PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XXXVI. DECEMBER, 1897. NO. 156.

Stated Meeting, September 3, 1897.

Vice-President PEPPER in the Chair.

Present, 26 members.

Mr. S. N. Rhoads, a newly elected member, was presented to the Chair, and took his seat.

Acknowledgments of election to membership were read from Mr. Owen Wister, Prof. Orton, Mr. Ely, Mr. Rhoads, Prof. Mabery, Mr. James Bryce, Lord Lister, Prof. Peckham, Dr. Nansen, Prof. Karpinsky and Prof. Tschernyschew.

Correspondence was submitted and donations to the Library were reported—the latter included a very valuable gift of sixty-two volumes and ten pamphlets of the publications of the British Museum, from the Trustees, for which a special vote of thanks was ordered to be transmitted to them.

The announcement of the decease of the following members was made:

Dr. Don Crescencio Carrillo y Ancona, Bishop of Yucatan, on March 19, 1897, æt. 59.

Prof. Johannes Japetus Steenstrup, Professor of History at the University of Copenhagen, on June 20, 1897, æt. 84.

Alfred M. Mayer, Professor of Physics in Stevens Institute of Technology at Hoboken, on July 13, 1897, æt. 61.

Dr. Frederick D. Stone, Librarian of the Historical Society of Pennsylvania, at Philadelphia, on August 12, 1897.

PROC. AMER. PHILOS. SOC. XXXVI. 156. W. PRINTED DEC. 16, 1897.

J. Sergeant Price, Esq., Treasurer of the Society, at Cape May, N. J., on August 16, 1897, æt. 66.

A communication for the *Transactions* was presented from Mr. John Van Denburgh, entitled, "Some Experiments with the Saliva of the Gila Monster (*Heloderma suspectum*)."

The following communications were read:

By Dr. N. F. Drake, a paper on "The Geology of the Indian Territory."

Mr. Clarence Alve, "Magnetism in Space."

The Finance Committee presented a report, announcing the death of the Treasurer of the Society, J. Sergeant Price, Esq.

It was ordered "that the Finance Committee be and is hereby authorized to draw upon the funds of this Society for the money necessary to pay the current expenses, and to receive its income during the vacancy in the office of Treasurer of the Society, and the said Committee is authorized to have possession of the financial papers and securities of the Society, until such vacancy shall be filled."

The Society was adjourned by the presiding officer.

A GEOLOGICAL RECONNAISSANCE OF THE COAL FIELDS OF THE INDIAN TERRITORY.[1]

BY NOAH FIELDS DRAKE.

(*Read September 3, 1897.*)

INTRODUCTION.

During the spring, summer and fall of 1896, the writer spent six months making a geological reconnaissance of the larger part of the Coal Measures and adjacent formations of the Indian and Oklahoma Territories. The best maps that could then be had of the region were exceedingly inaccurate. In connection with geologic observations, sketch maps were therefore made of areas that were especially important. Nearly all the area south and east of the Canadian river, shown on the accompanying map, was sketched

[1] A thesis for the degree of Doctor of Philosophy, presented to the Department of Geology of the Leland Stanford, Jr., University, May, 1897.

and studied rather closely, partly because the coal beds of that area are valuable economically, and partly because the folded structure and the resulting topography are of special geologic interest. The bordering areas of the Boone chert and limestones were studied because these beds have a wide distribution, and a knowledge of their relations to overlying beds was essential to an understanding of the structure of the area and of the conditions of deposition.

PART I.

Structural Geology.

Area of the Reconnaissance.—The area over which the reconnaissance was made includes the northern part or nearly half of the Indian Territory, and a little of the adjoining part of Oklahoma. It includes the Cherokee, Creek and Seminole Nations, all the Indian Nations in the northeast corner of the Indian Territory, the northern part or nearly one-third of the Choctaw Nation and a little of Oklahoma adjoining the Creek and Cherokee Nations.

The area is about 165 miles long and about 125 miles wide and covers a little more than 20,000 square miles.

Previous Investigators.—In 1819, Thomas Nuttall[1] made several excursions across this region to study its botany and geology. He passed over the country southwest of Ft. Smith, Ark., between Sugar Loaf and Cavaniol mountains[2] and across Winding Stair mountains; then he went up the Arkansas river to Verdigris river and across the country in a southwesterly direction from Verdigris river. He also went up Grand river to the Salt springs and made short excursions in the vicinity of Salisaw and Lee's creeks. His conclusions regarding this field were: that sandstones, shales and coal-bearing rock extend over most of the area; that limestones and cherts all lie north of the Arkansas river; that the salt-bearing strata of Grand river are different from the salt-bearing red beds in the southwest, and that the mountain chains in central western Arkansas and central Indian Territory have a southwest trend.[3]

[1] *A Journal of Travels into the Arkansa Territory*, by Thomas Nuttall, Philadelphia, 1821, pp. 146–177.

[2] *Cavaniol, Caveniol* and *Kavanaugh* are the different ways of spelling the name applied to the mountain lying between the Sugar Loaf and the Sans Bois mountains. *Cavaniol* is the oldest spelling of the name that has been found, and is the one used in this report.

[3] *Jour. Acad. Nat. Sci.*, Vol. ii, p. 49.

In 1822, Edwin James[1] published a geologic section and some explanatory notes of that part of this country lying along the 35th parallel of north latitude. This publication, however, gave very little additional information concerning the geology of this area since it only showed the Ozark mountain strata to be Carboniferous, and the rocks of the Canadian river country to be red beds bearing salt and gypsum.

In 1853, important geologic observations in this country were made by Jules Marçou,[2] geologist to the Pacific Railroad Expedition. His reconnaissance in this field was principally confined to the area lying immediately south of the Arkansas and Canadian rivers. The important additional geologic knowledge he gave of the area was: a better knowledge of the coals, the lithology, and the structure along the line of reconnaissance. He considered the Ozark mountain area an outlying or second fold of the Allegheny mountains.[3]

George G. Shumard made the statement before the St. Louis Academy of Science, in 1857, that he had traced the coal fields from Ft. Smith, Ark., to Ft. Belknap, in Texas.[4] He apparently did not note the break in outcrop of these beds in the southwestern part of the Choctaw Nation, where the Carboniferous is concealed by the overlying Cretaceous.

In 1890, H. M. Chance[5] published "The Geology of the Choctaw Coal Fields," which is the most valuable information yet published on the geology of this area. In this paper he locates the relative stratigraphic position in the Indian Territory of the three productive coal beds, and clearly outlines by description, sections, and maps, most of the Grady and McAlester coal beds along the outcrop from six or seven miles west of McAlester to near the Poteau mountains. He gives a section from the base of the Grady coal bed to the top of Cavaniol mountain, which includes the productive part of the Coal Measures. He also notes the prevailing S. 80° W. axes of folds and the system of southwest folds.

In 1891, R. T. Hill[6] published a paper outlining the Ouachita

[1] *Jour. Acad. Nat. Sci.*, Vol. ii, pp. 326–329.

[2] *Pacific Railroad Reports*, Vol. iii, Part iv. pp. 123–127.

[3] "Esquisse d'une classification des chaines de montagnes d'une partie de l'Amérique du Nord," *Annales des Mines*, 5 me. sér., Tome vii, pp. 339, 340.

[4] *Trans. Acad. Sci.*, St. Louis, Vol. i, p. 93.

[5] *Trans. Amer. Inst. Min. Eng.*, 1890, Vol. xviii, 653–661.

[6] *Amer. Jour. Sci.*, Vol. xlii, August, 1891, pp. 111–121.

Mountain System in the Indian Territory, which further classified the knowledge of this system.

The work of the Arkansas and the Texas geological surveys, the geologic investigations in southeastern Kansas by Prof. Charles S. Prosser, and an unpublished sketch map kindly furnished by Prof. Orestes St. John, showing the general distribution of the geologic formations in the Indian Territory, further assisted in giving an idea of the geology of this area. Taken as a whole, however, the field was comparatively a new one to geologists and it is rather remarkable that it should have so long remained so little known.

Hydrography.—Nearly all of the area under consideration is drained by the Arkansas river and its tributaries. A very little of the southern part, however, is drained by streams tributary to the Red river. The Arkansas river enters the country under discussion a little south of the northwest corner, and runs in a southeasterly direction, thus crossing it diagonally through the central portion. To the north of this river the larger streams, the Illinois, the Grand, the Verdigris, and the Little Verdigris or Caney rivers, flow nearly southward and empty into the Arkansas river. The Illinois river, however, is somewhat deflected to the westward, and the Verdigris and Caney rivers deflected to the eastward. The streams on the north thus have a tendency to flow into the Arkansas river at the same locality.

To the south of the Arkansas river the Cimarron and the Canadian rivers are its largest tributaries. The Cimarron, the most northerly of the two, flows eastward into the Arkansas river, while the Canadian river is slightly deflected to the north in its eastward course, and enters the Arkansas river about twenty miles below the collecting basin of the streams to the north. Between the Cimarron and Canadian rivers, the Deep Fork and North Fork of Canadian rivers, flow almost eastward and unite a short distance above their confluence with the Canadian.

Topography.—There are three general topographic groups in this area. One is the elevated and folded area to the south, which is an extension of the Ouachita mountain system; a second group is the elevated plateau area in the northeast, which widens slightly southward to near the Arkansas and the Grand rivers. This belongs to the Ozark plateau system. The third group is a broad plain-like area that slopes gently eastward in terrace-like escarpments and undulations, and narrows into the low depression between the Ozark

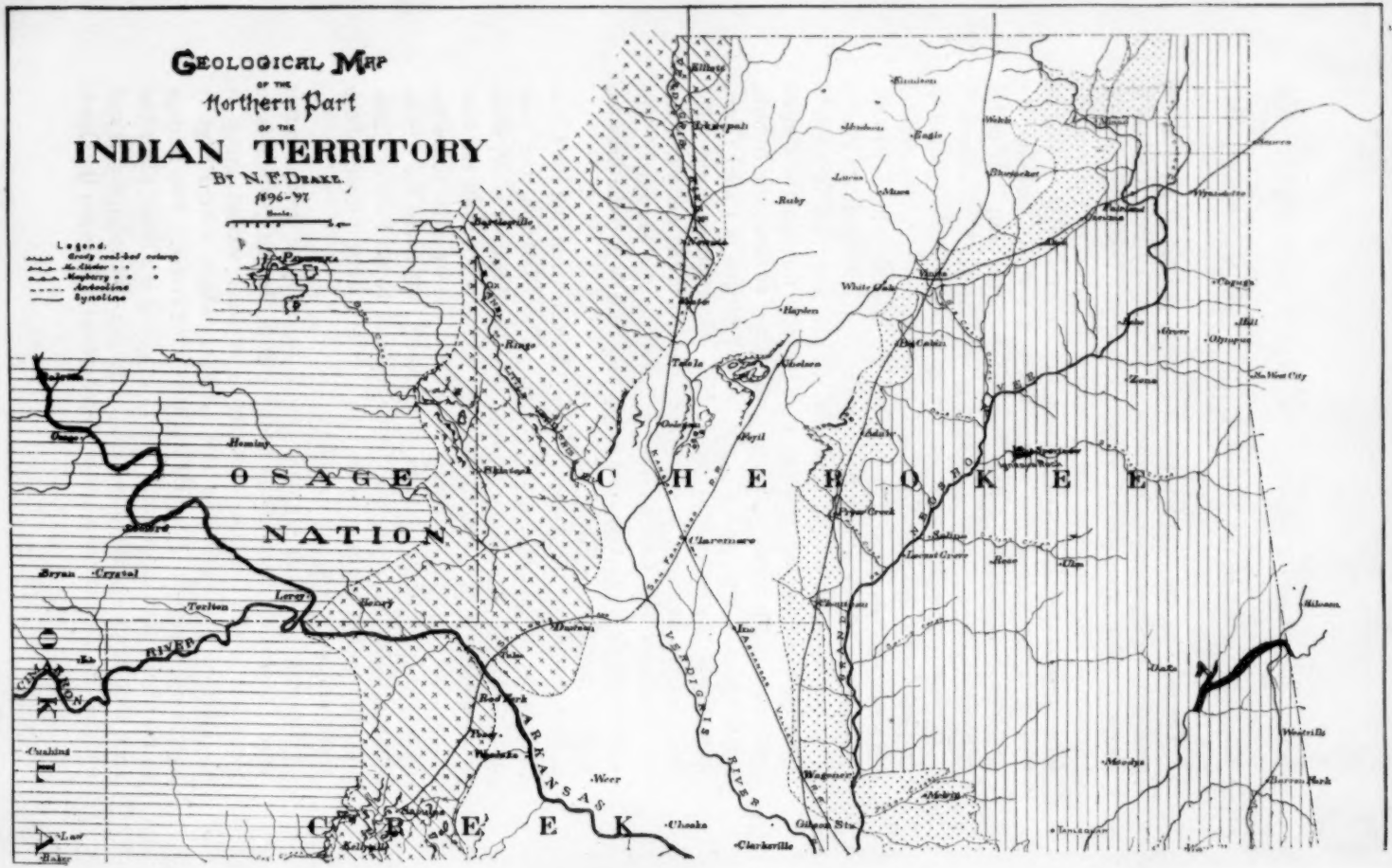

GEOLOGICAL MAP
OF THE
Northern Part
OF THE
INDIAN TERRITORY
BY N. F. DRAKE.
1896-97
Legend.
OSAGE
NATION
CHEROKEE
CREEK
ARKANSAS
CIMARRON
RIVER
VERDIGRIS
RIVER
NEOSHO
RIVER
Pawhuska
Bartlesville
Dewey
Ramona
Copan
Hogshooter
Caney
Rings
Creek
Hominy
Skiatook
Bigheart
Osage
Bryan
Crystal
Terlton
Lorena
Keifer
Red Fork
Keystone
Weer
Cheeka
Kellyville
Cushing
Law
Baker
Claremore
Pryor Creek
Salina
Locust Grove
Rose
Chouteau
Mayes
Wagoner
Gibson Sta.
Clarkesville
Tahlequah
Hulbert
Eldon
Ruby
Lawton
Mazie
Hayden
Tenkiller
Big Cabin
Zena
Grove
Afton
Miami
Quapaw
Commerce
Wyandotte
Peoria
Picher
Cardin
Quapaw
Seneca
Hockerville
Eagle
Wilson
Welch
Narcissa
Spavinaw
Maysville
Westville
Moodys
Barren Fork
Tahlina
Illinois
Dillard
Eucha
Jay
Grand
Saline
Neosho
Wyman
Hilbum
Oaks
Watts
Siloam
Springs
Gentry
Decatur
Gravette
Sulphur
Springs
Centerton
Pea Ridge
Rogers
Bentonville
Bella Vista
Garfield
Berry
Farmington
Prairie
Grove
Lincoln
Fayetteville
Elkins
Winslow
Greenland
Johnson
Springdale
Tontitown
Elm Springs
Goshen
Evansville
Summers
Combs
Huntsville
Witter
Boston
Marble
Falls
Yellville
Flippin
Summit
Mountain
Home
Norfolk
Cotter
Gassville
Big
Flat
Mountain
View
Oil
Trough
Springs
Calico
Rock
Batesville
Cushman
Newport
Jacksonport
Swifton
Tuckerman
Augusta
Cotton
Plant
Des
Arc
Hickory
Plains
Hazen
Carlisle
Lonoke
Cabot
Ward
Beebe
Searcy
Kensett
Bald
Knob
Judsonia
Bradford
Griffithville
Russell
Rosebud
Quitman
Clinton
Heber
Springs
Greers
Ferry
Dam
Edgemont
Shirley
Enola
Damascus
Guy
Mount
Vernon
Twin
Groves
Wooster
Greenbrier
Conway
Morrilton
Plumerville
Nemo
Vilonia
Mayflower
Scott
Austin
Ward
Cabot
Beebe
Searcy
Kensett
Bald
Knob
Judsonia
Bradford
Griffithville
Russell
Rosebud
Quitman
Clinton
Heber
Springs
Greers
Ferry
Dam
Edgemont
Shirley
Enola
Damascus
Guy
Mount
Vernon
Twin
Groves
Wooster
Greenbrier
Conway
Morrilton
Plumerville
Nemo
Vilonia
Mayflower
Scott
Austin

Plate I.

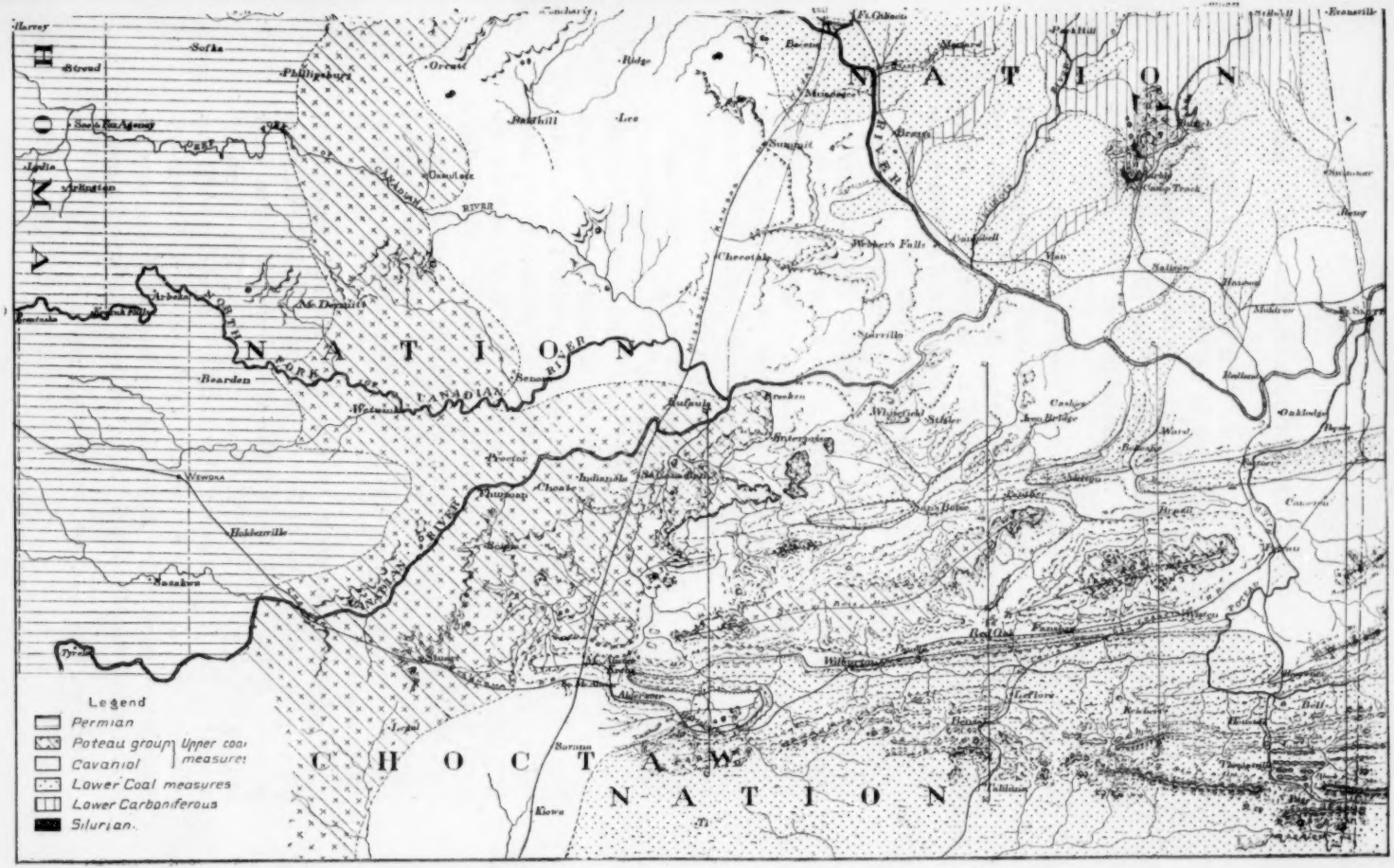

C H O C T A W
N A T I O N
Legend
Permian
Poteau group
Cavanial
Upper coal measures
Lower Coal measures
Lower Carboniferous
Silurian.

Plate I.

and the Ouachita mountain systems. The westward deflection of the Illinois and Grand rivers is due to the Ozark uplift, while the northern deflection of the Canadian river is caused by the uplifted folds of the Ouachita mountain system. Thus the rivers approach each other on either side of the Arkansas river along the border lines of these topographic groups.

The Ozark Mountain System.—This term was formerly applied to the mountainous area of southern Missouri, northwestern and central western Arkansas and east central Indian Territory. The name is, however, properly restricted to the plateau or northern part of this area, and the name, Ouachita, has been applied to the folded mountains of the southern part of the area.

The Ozark mountains in the Indian Territory are divided into two distinct topographic areas. One lying east of Grand river and north of Tahlequah and Evansville is the lower table-land of the two, and contains flat lands and also areas of sharp narrow ridges and small V-shaped canyons. The other portion of the Ozark system is more elevated and is the western prolongation of the Boston mountains. This area is triangular in shape; the apex of the triangle is about four miles southeast of Fort Gibson, the base lies south of Evansville, and is about fifteen miles across, measured along the Arkansas-Indian Territory line. This table-land is about 1500 feet above tide-level. It is usually bounded by steep escarpments on the north side and by both escarpments and slopes on the south. Several streams have cut through this plateau and at present flow through narrow valleys or canyons. The escarpment on the north side of the Boston mountains has a general east-west direction, but it is a very irregular line with plateau tongues and outliers extending northward along the face of the mountain; these are erosion remnants showing the former extension of the lower carboniferous strata.

The Ouachita Mountain System.—The elevated topographic group in the southern part of the field is an extension of the Ouachita mountain system which forms such a typical area of folded strata and parallel ridges and valleys in western Arkansas. This system was named[1] by Dr. J. C. Branner, who thinks it is an outlier of the Appalachian system and the structural equivalent of the Cincinnati-Nashville anticline. The Appalachian system, he thinks, once extended across the Mississippi Valley south of the Ouachita moun-

[1] *Ann. Rept. Geol. Surv. Ark.*, Vol. ii, 1888, p. 175.

tains, through Mississippi, Louisiana and central Texas.[1] There are two principal types of mountains in the Ouachita system; one of these consists of long ridges, the other is the bench-and-bluff and flat-topped mountain type. The mountains, ridges and valleys of this region trend almost east and west, corresponding to the folds.

The Canadian river and the Arkansas river from the mouth of the Canadian river to Arkansas, practically form the northern boundary of this group. For some fifteen to twenty miles south of these rivers low isolated buttes, table-lands and ridges such as Long mountain, the Seven Devils, McChar mountains and Backbone mountain are the outliers to the typical part of the mountain system. Immediately south of these outliers are the Sugar Loaf, the Cavaniol and the Sans Bois mountains, each rising nearly 3000 feet above tide-level. They all trend about S. 80° W., but are completely separated.

These three mountains, together with the Poteau mountains, and many smaller elevations, are of the bench-and-bluff type. The mountains farther to the south, the Walker, the Blue, the Winding Stair, the Black Fork and the Rich mountains are of the ridge type.

Prairie Plains.[2]—The third topographic division comprises all the country north of the Canadian river and west of Grand river. The predominant topographic feature of this division is a broad southeastward sloping plain, broken by gentle irregular undulations and by long lines of escarpments facing east or east-southeast. Of these features the east-facing escarpments are the most conspicuous. They are usually but fifty to one hundred feet high, although often from ten to fifteen miles long, and even much longer if local breaks are not taken into account. Occasionally gentle westward slopes extend from the top of one escarpment back to the base of the one next west of it, but usually the inclination is not sufficient to bring the base of the western escarpment down to the level of the eastern one.

Structure of the Topographic Groups.—In each of these topographic groups the geologic structure accounts for the topographic forms. The plateau type in the northeast has its strata almost horizontal; the folded type in the southern part of the field has its strata irregularly folded along nearly parallel lines; in the western

[1] *Proc. Bost. Soc. Nat. Hist.*, Vol. xxvi, p. 477; *Am. Jour. Sci.*, November, 1897, pp. 357–371.

[2] J. W. Powell, *National Geogr. Monographs*, Vol. I, No. 3, p. 83.

part of the field the escarpments and undulating topographic features are due to the varying resistant power of gently westward dipping beds.

Ouachita Mountain Structure.—In the central and northern part of the Ouachita area the mountains and mesas are practically all synclinal in structure, and the deeper and broader synclines form the larger mountains, such as Sugar Loaf, Poteau, Cavaniol and San Bois mountains; the mesas, such as the Seven Devils and McChar mountains, occupy the smaller synclinal folds. In the southeastern part of the field all the mountains and ridges are upturned edges of extensive hard rock beds. There is every gradation from the sharp ridge with equal slopes on either side and its steeply dipping strata, to the escarpment or bench topography with its gently dipping beds.

Ouachita Valley Structure.—In the central and northern part of the Ouachita area most of the larger valleys lie along anticlinal axes, while in the southeastern part of the field the valleys are in the softer strata or along faults, and are nearly always parallel to the structural lines.

Folds and Faults.—The folds and faults belong principally to that part of the field included in the Ouachita mountain system. The limits of the folded area are not sharply marked, however, and there are isolated folds and faults through and around the Ozark mountains. There are two distinct systems of folds, a primary system and a secondary one. The axes of the most characteristic or primary system run about S. 80° W. The axes of the secondary system run approximately northeast–southwest, but the different folds of this system vary much in direction on either side of the general direction. It does not appear that these two systems of folds are of different ages, because the topographic features have developed equally along corresponding kinds of folds regardless of the direction of their axes, and also because the two systems are intimately related, as is shown by certain folds lying in both systems. As already stated, the axes of the principal folds run nearly east and west and the folds are quite regular. The distinctness of the secondary folding is shown by the general southwest direction of many axes and by the west-northwest dip of all the rock beds in the central and western part of the whole area of the reconnaissance. These western beds dip nearly northwest in the southern part of the area, to the west-northwest in the central, and to the west in the

northern part of the Indian Territory. Thus the strike swings around so as to become parallel to the western end of the Ozark mountain uplift. This secondary system of folds is more characteristic of the northern part of the region, thus further showing its intimate connection with the Ozark mountains. So it appears that the force that threw the Ouachita mountain system into east and west folds at the same time uplifted the Ozark mountains to the north and started secondary north-south folds.

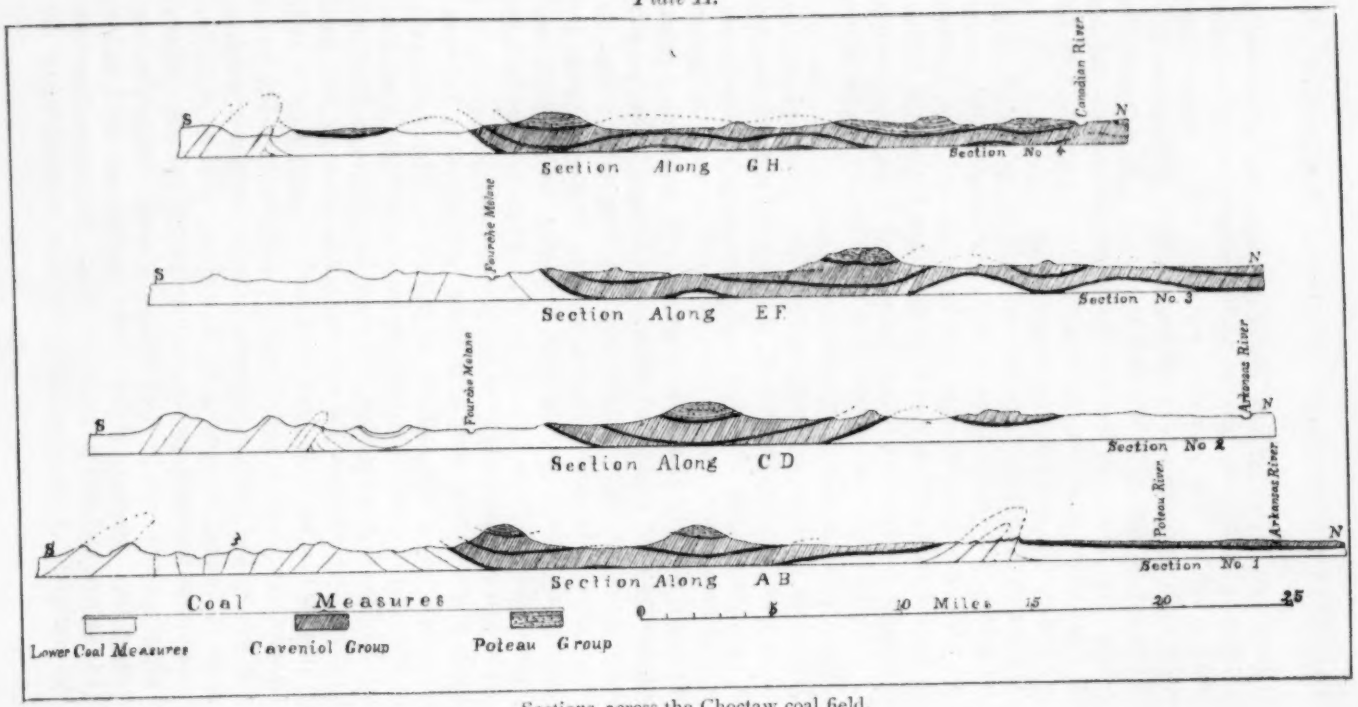
The sketch map of the Choctaw coal field shows that there are three groups of the south 80° west folds that are especially prominent. The group on the north is anticlinal and runs westward from immediately south of Pocola, passing near Farmer and Milton, and running through Sans Bois to the west end of Sans Bois prairie. This group includes three separate anticlinal folds, or the Backbone, the Bokoshe-Milton and the Sans Bois anticlines.

The group lying immediately south of this is composed of three separate synclines, the Sugar Loaf, the Cavaniol and the Sans Bois synclines, giving axial direction to the mountains of those names. The third group, farther to the south, is anticlinal and extends from immediately north of Heavener westward, with some minor deflections, passing near Krebs and through McAlester. This is a continuous anticlinal fold. To the north of these three groups the folds are more gentle and irregular, while to the south of them the folding is also more irregular and decidedly more violent and accompanied by faulting. So in the southern part of the field the structure can only be worked out by detailed study.

Folds of the second system, or those running nearly northeast-southwest, are all gentle and not so extensive. The most prominent folds of this system are those separating the Sugar Loaf, Cavaniol and Sans Bois mountains, and those lying between Ward and Whitefield. Of all these the one separating Cavaniol and Sans Bois mountains is the most prominent, and it is only a gentle roll.

Characteristics and Origin of the Folds and Faults.—The intensity of folding and faulting increases quite regularly southward, as is shown in Secs. 1, 2, 3 and 4, Pl. II, and this intensity of folding extends further westward in the southern part of the area. Along any given east and west line the folding is usually more intense to the east; this, however, is due chiefly to the southward deflection of the west end of the principal folds. As a rule, the strata on the north side of anticlinal folds dip more steeply than on the

Plate II.

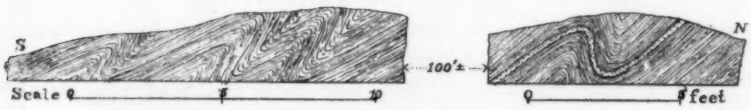


Sections across the Choctaw coal field.

south side of the same folds, as is shown in Secs. 1, 2, 3, 4, 5, 6, 8, and A. This feature is more marked where the folding is intensified. Where the anticlines are very closely pressed, overthrows to the north and often faulting along the north side of the anticlines are the usual consequences; this is shown in Secs. 5, 6 and Pls. II and VII. In the Ozark mountain area the faults are usually normal, while in the Ouachita area the faults are along anticlines.

All mountains of importance in the southern part of the field (Walker, Black Fork, Rich, Blue, Winding Stair, Jack Fork and Kiamichi mountains) have practically all their beds dipping south about 40°. Throughout the area including these mountains, the folds are so closely pressed, overthrown, and faulted that the strata no longer show broad anticlines with low dips.

The elevation of the region, the increased intensity of folding toward the south, and the overthrows toward the north all show an upward and northward movement of the rock beds at the time of folding. In places these movements of the strata have produced wrinkles like that shown in Sec. A.



Sec. A. To illustrate Ouachita folded structure. Sketched from exposures along a railway cut, five miles southeast of Bengal.

This movement has tilted beds 40° to the south, the angle at which they best resisted breaking and crushing. As noted by Marcou,[1] Branner[2] and Griswold[3], these disturbances are probably contemporaneous with the Allegheny mountain uplift, and as noted by Winslow[4] they are probably due to the raising of the isogeotherms in the great thickness of Paleozoic beds.

Lithology of the Area of the Reconnaissance.—This field includes both igneous and clastic rocks. The igneous rocks, however, are confined to one small granitic dike in the Cherokee Nation. Among the clastics, shales, sandstones, limestones and cherts have extensive developments.

[1] *Annales des Mines*, 5me sér., vii, pp. 339, 340.
[2] *Ann. Rep. Geol. Sur. Ark.*, 1890, iii, p. 213.
[3] *Proc. Bost. Soc. Nat. Hist.*, xxvi, pp. 474–479.
[4] *Bull. Geol. Soc. Am.*, 1891, ii, pp 231–234.

Igneous Rocks.

Previous Knowledge of the Igneous Rock.—The existence of igneous rock in the Cherokee Nation has been known for a long time. It was referred to in D. D. Owen's *Second Report of the Geology of Arkansas* as a red granite which occurred at the mouth of Spavinaw creek, some thirty or forty miles west of the Arkansas line. Edward T. Cox failed to find the granite in place, but saw some millstones that were made from it, and obtained specimens which were broken off in fashioning the millstones. He thought this granite underlay the sedimentary rocks of southwestern Missouri and northwestern Arkansas.[2]

The exact locality of this granite outcrop has, however, apparently never been definitely known to any one interested in the geology of the country until 1896, when the writer, after a special search, found the rock in place.

Locality and Mode of Occurrence.—The rock occurs in the Cherokee Nation, on the north side of Spavinaw creek, about six miles from its mouth and three-fourths of a mile west of Spavinaw post-office. It is a dike about twelve hundred feet long by fifty feet wide. The outcrop is not continuously exposed, but the breaks are probably due to a thin covering of detritus from the clastic rock. There are four exposures of the dike rock, which vary in length from about one hundred to two hundred feet, and occur at intervals of about two hundred feet.

This dike runs along the axis of a gentle anticlinal fold which extends about N. 30° E. The dips of the sedimentary beds on either side of the dike are only 5° to 10°, but the fold is broad and affects the rocks for two to three miles to the west and probably as far to the east. Silurian strata which, over the adjoining country, are usually covered by two hundred to five hundred feet of Lower Carboniferous beds, are here exposed to a depth of about two hundred feet and outcrop in the valley, as shown in Pl. III. The Silurian strata along the contact of the dike appear to be free from any special metamorphic action due to the dike rock.

Macroscopic Characters.—The general color of the rock is a light brick red with a mingling of black specks which are slightly grouped and in places so much as to give it a somewhat

[1] *Second Report of a Geological Reconnaissance of the Middle and Southern Counties of Arkansas, 1859 and 1860*, pp. 404, 408.

[2] *Ibid.*, p. 408.

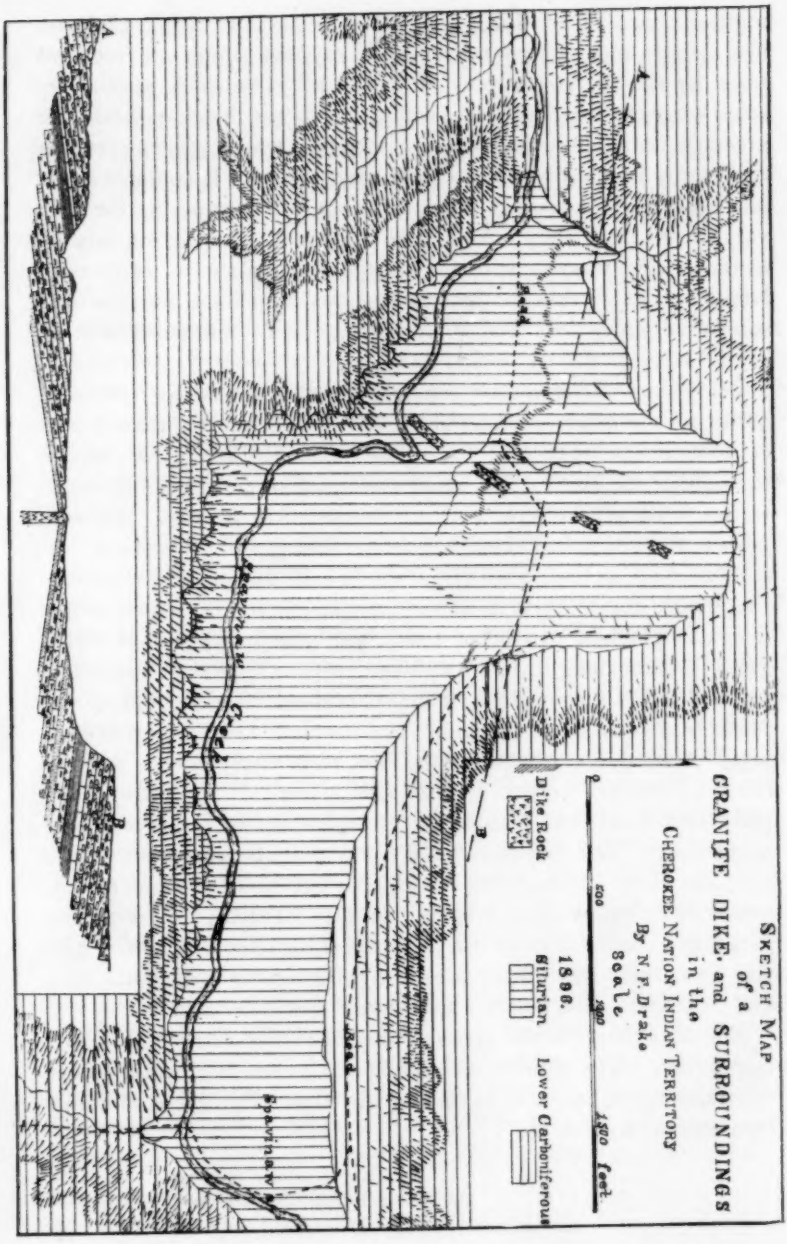

Sketch Map
of a
GRANITE DIKE and SURROUNDINGS
in the
Cherokee Nation Indian Territory
By N. F. Drake
Scale
0 600 1200 1800 feet
1896.
Dike Rock
Silurian
Lower Carboniferous
A
B
Spavinaw Creek

Plate XLI.

mottled appearance. In the red color are blended a light pink and also deeper red, due to the feldspar crystals, which are red and form by far the larger part of the rock. The black specks are small magnetite crystals. Associated with the black crystals are greenish hornblende and chlorite crystals, which give a greenish tint hardly noticeable on a casual observation. It contains also a few small white quartz crystals. The crystals composing the rock vary in size from those which give a general granular appearance to the ground mass to feldspar crystals that are 1 c. m. or more in length. The freshly broken rock shows a general fine-grained, somewhat shiny and bright appearance with numerous shining crystal faces of the larger feldspars.

Microscopic Examination.—Feldspars, quartz, chlorite and magnetite are the principal minerals of the rock, while hornblende and epidote occur sparingly. A holocrystalline texture is shown throughout the rock. The most striking and general microscopic feature is its granophyric and micropegmatitic texture. Through most of the orthoclase crystals quartz is intergrown in the most intimate manner, so that each feldspar shows radiating or parallel alternating quartz and feldspar in narrow bands, which form fan-shaped or irregular patches. In other cases, the quartz appears in triangular sections along lines through the feldspar crystals, or is micropegmatitic. In any given feldspar crystal, the included quartz plates or prisms show the same orientation. Quartz occurs sparingly isolated in larger crystals, but very rarely shows its outlines. Feldspars are the predominant minerals. They are principally orthoclase, but plagioclase feldspars are of rather common occurrence. The feldspars have a fine granular appearance and a reddish color. Phenocrysts of feldspar are quite common; they, however, generally show irregular outlines instead of crystal faces. Magnetite occurs in small opaque masses, many of which show perfect crystal outlines. They show a slight grouping through the rock and in places give a blended appearance to the crystals.

The hornblende is the greenish variety and of rather uncommon occurrence. The chlorite is common and occurs in greenish bands, spherular aggregates and in minute particles. Epidote is of rather common occurrence.

Chemical Analysis.[1]—	PER CENT.
Loss on Ignition	1.11
Silica (SiO_2)	71.10
Ferric Oxide and Alumina (Fe_2O_3 and Al_2O_3)	20.60
Calcium Oxide (CaO)	2.53
Magnesium Oxide (MgO)	0.99
Potassium and Sodium Oxide (K_2O and Na_2O)	3.76
Total	100.09

Classification of the Rock.—The high percentage of silica, the holocrystalline texture and the general interference of crystallization shown in the irregular crystal outlines at once place the rock in the granitic series. As shown by the feldspars, quartz and magnetite, however, there is a strong tendency to the porphyritic texture: it is, therefore, a porphyritic granite. The minute textures of the feldspars and quartz is designated by the name granophyre.

Age of the Dike.—As noted above, the dike breaks through Silurian strata along the axis of an anticlinal fold. The Lower Carboniferous strata overlying the Silurian are tilted by this fold. The igneous rock was, from this evidence, most likely protruded at the time of the folding. This anticline is one of the outlying folds of that mountain system which is such a marked feature of central western Arkansas and the adjoining part of the Indian Territory. This system of folding is post-Carboniferous, pre-Cretaceous and quite likely pre-Mesozoic, because Upper Coal Measures deposits are folded, Lower Cretaceous deposits lie almost undisturbed upon these folds and no Jurassic or Triassic beds occur over the area.

Relation to the Igneous Rocks of Other Areas.—This dike in the Cherokee Nation is equally distant from three different igneous rock areas, and about two hundred miles from either of them. One lies in southeastern Missouri, one in central Arkansas and the other in the Choctaw and Chickasaw Nations, Indian Territory. The igneous rocks of this latter-named area have not been studied by any one sufficiently to make satisfactory comparisons. The igneous rocks of Arkansas are quite different from the Spavinaw granite. Those of Arkansas "belong to the eleolite syenites and their associated dike rocks;" they are gray or blue in color[2] and are post-Car-

[1] Analysis made by Mr. Chester A. Thomas.

[2] *Ann. Rept. Geol. Surv. Ark.*, 1890, Vol. ii, p. 3.

boniferous in age. In texture, color and mineralogical composition many of the Missouri granites closely resemble those of the Spavinaw area. The resemblance is especially true of the granophyric and micropegmatitic texture. Dr. Haworth says:[1] "The distribution of rocks exhibiting such structure is very wide; there is scarcely a granite in the State in which portions of it are not represented. . . . . The small outlying granitic areas generally have this structure throughout. . . . . This structure is common in the porphyries also."[2]

Iron oxide is a rather common constituent of the Missouri granites, and is especially common in the porphyries.[3] These properties in general are also characteristic of the Spavinaw rock. The age of the Missouri granite, however, is apparently different since it has been referred to the Archean.[4]

Clastic Rocks.

The clastic rocks which cover all this area, except the small dike described, belong to the Silurian, the Lower Carboniferous, the Coal Measures and the Permian.

The Silurian occurs in a few narrow valleys in the northeastern part of the area. The Lower Carboniferous covers about half of the Cherokee Nation, or the northeastern part of the field under discussion. The Coal Measures cover all the rest of the area except a narrow strip along the western edge, which is Permian.

Silurian.

The Silurian areas lie in narrow strips along valleys in the Cherokee Nation, where stream erosion has cut down through the overlying Lower Carboniferous beds. In some places folding has elevated these lower beds so that erosion has more readily exposed them.

Structure.—The Silurian strata lie almost horizontal and closely conform to the inclination of the overlying Lower Carboniferous beds.

Lithology.—The strata are composed of saccharoidal sandstones, marble or highly metamorphosed limestones, chert and dolomitic calcareous sandstones.

[1] *Mo. Geol. Sur.*, Ann. Rept., 1894, Vol. viii, pp. 165-166.
[2] *Ibid.*, p. 193. [3] *Ibid.*, pp. 141, 188. [4] *Ibid.*, pp. 95-96.

Local Development.—The localities where the writer saw and examined Silurian deposits are on Spavinaw creek six to seven miles from its mouth, along the Illinois river southeast of Oaks, along Salisaw creek at and near Marble and on Elk creek west of Bunch.

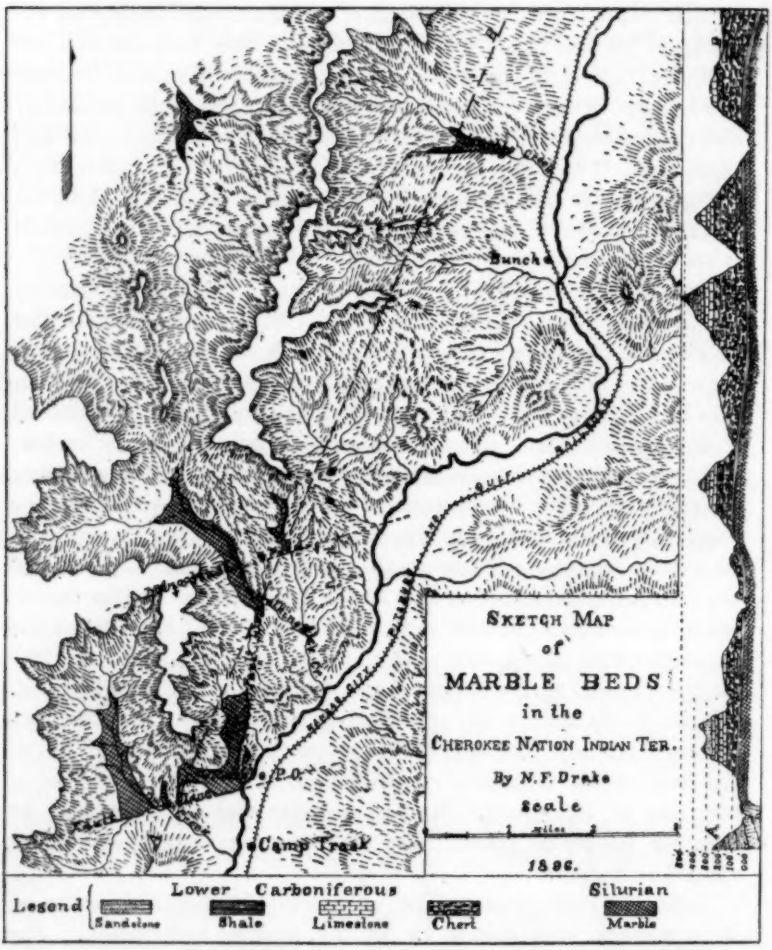
Spavinaw Creek Area.—The area on Spavinaw creek is shown in Pl. III. It is about one mile square, and is exposed mainly on account of an anticlinal fold which elevates the beds so that the erosion of Spavinaw creek has reached and cut into them. About two hundred feet of the strata are exposed. The rocks are mainly cherty limestones, cherty calcareous sandstones and saccharoidal sandstones. The lowest exposed strata lie practically in contact with the igneous dike and are composed of fossiliferous chert. Along the creek at Spavinaw post-office twenty feet or more of the Silurian strata are exposed.

Illinois River Areas.—At the Stewie ford of the Illinois river on the Cincinnati-Oaks road, about seventy-five to one hundred feet of Silurian strata are exposed in the bluffs and the hillsides along the valley. These strata are mainly saccharoidal sandstones, rather thin bedded, but sandy clay shale is quite frequently interstratified with the sandstone. These clays are of a light gray color and in places are slightly blue, and some are yellowish. Silurian strata are exposed on the above-named road also about two miles to the northwest of the ford, at which exposure the beds are saccharoidal sandstones dipping slightly to the southeast. Good exposures of the thin bedded sandstone and shales may be seen at the Stewie schoolhouse about one-half mile northwest of the ford. From the exposures seen along and near the river, it seems likely that the outcrops extend several miles up and down the valley from the ford. Silurian strata are reached by this river erosion along the Arkansas-Indian Territory line, and they are nearly reached in the bed of the river east of Greenleaf courthouse, some twelve to fifteen miles southeast of Tahlequah. So it is probable that exposures may be seen for twenty or thirty miles along the river valley within the Cherokee Nation.

Salisaw Creek Areas.—The exposures of Silurian deposits on Salisaw creek were caused by folding, faulting and erosion. The location and areal outcrop of these beds are shown in Pl. IV. The Silurian strata nowhere rise high upon the hillsides, but are almost entirely confined to the deeper erosion channels of the valleys and cañons. They are exposed, however, only where folding or fault-

ing has brought them to a higher level than they would otherwise have reached. There are in this area two systems of folds and fault lines; one runs about 10° south of west, and the other 10° east

Plate IV.



of north. One of the S. 80° W. fault lines runs from a point about one-half mile southeast of Marble P. O. westward across Dry creek. From the first-named point, a fault line runs N. 10° E. across Walkingstick creek, where it meets a monoclinal fold running

nearly east and west apparently. The uplift of the monoclinal fold being on the north side, outcrops of the Silurian strata extend farther east on that side of the fold. Another east and west anticlinal fold appears to lie about one mile north of Bunch. Silurian rocks are exposed along this uplift one and a half miles northwest of Bunch, and on Elk creek about six miles W. N. W. from Bunch.

Lithology of the Salisaw Creek Area.—Marble and saccharoidal sandstone are practically the only kinds of rocks exposed in these outcrops. There is, however, a bed of chert some twenty-five feet thick one-half mile west of Marble, which is most likely Silurian. This chert consists of angular pieces, from an eighth to a fourth inch in diameter, of pink and also white chert scattered through a ground mass of gray chert. At the base of the chert bed, there is some saccharoidal sandstone containing chert nodules. The saccharoidal sandstone usually lies at the top of the Silurian beds in this area, and is from one inch to twenty-five or thirty feet thick. The grains composing the sandstone vary considerably in size: the largest are about two millimeters in diameter. These sandstones may be seen along Walkingstick creek above the Marble bed, at almost every place where the top of the marble is exposed. They also outcrop one-half mile east of Marble on Salisaw creek, and northwest of Marble along Dry creek. The marbles are generally of a pink color, rather coarsely crystalline, seamed, and lie in massive beds; twenty-five to thirty feet of massive marble is exposed at all the larger Silurian areas marked on Pl. IV, and the base of the marble was not seen at any place. Mr. J. D. Rice, who quarries marble at Marble P. O., gave me the following section from a drill hole on Dry creek, northwest of Marble P. O.

	FEET.
Pink marble	25
Light gray marble	100
Deep pink marble	2½
Dark gray marble	2½
Deep pink marble	5
Dark gray marble	1

Relation to the Silurian of Arkansas.—A section[1] of the Silurian deposits in Arkansas gives something over one hundred and fifty feet of pink, chocolate and gray-colored marbles on top, which beds

[1] *Ann. Rept. Geol. Sur. Ark.*, 1890, Vol. iv, pp. 10, 11, 214.

are called St. Clair marbles. These beds are underlain by blue and gray limestones called the Izard limestone. The Izard limestone is underlain by saccharoidal sandstones, magnesian limestones and cherts.

All the Silurian deposits seen in the Indian Territory, except the Salisaw and Elk creek areas, are composed of saccharoidal sandstones, cherts and calcareous, magnesian sandstones. The Salisaw and Elk creek Silurian rocks, however, are mainly pink and gray marbles, and therefore appear to be the equivalent of the St. Clair marble, while the Illinois river and Spavinaw creek areas belong to the beds below the Izard limestone.

The St. Clair marbles in Arkansas are principally confined to Independence, Izard, Stone and Searcy counties, in the northern part of the State. The Izard limestones have a somewhat wider range,[1] but neither the St. Clair marble nor the Izard limestones are known as far northwest as Benton county, Ark.,[2] or to the west of Benton county, in the Indian Territory. So it appears that these topmost Silurian beds were eroded in the northwest to a greater extent than they were to the south and east, before they were covered by later deposits. Dr. Henry S. Williams,[3] principally from biological investigations, has determined the top of the St. Clair marble to be of Clinton-Niagara age, and the lower part of it to be of Trenton age. From the thickness of the marble beds in the Salisaw creek areas, as shown by drill holes, it is probable that the outcropping part is the equivalent of the Clinton-Niagara part of the St. Clair.

Lower Carboniferous.

Area.—The Lower Carboniferous is confined to the northeast part of the Cherokee Nation and is roughly bounded on the west by the Grand or Neosho river and on the south by the Boston mountains. This area covers about three thousand square miles, approximately one-half of the Cherokee Nation.

Lithology.—The rocks composing the Lower Carboniferous are cherts, limestones, shales and sandstones.

Structure.—The beds as a rule are practically horizontal, especially in the northeastern part of the area. Along the western border of

[1] *Ann. Rept. Geol. Sur. Ark.*, 1890, Vol. iv, p. 112.
[2] *Ann. Rept. Geol. Sur. Ark.*, 1891, Vol. ii, pp. 27–32.
[3] *Am. Jour. Sci.*, 1894, Vol. cxlviii pp. 328, 329.

the area the strata dip slightly to the west, while along the southern border they are somewhat disturbed by gentle folds which usually run a little south of west by north of east; but many run about northeast by southwest. The general result of the disturbance is to make the strata dip with varying steepness to the south.

Eureka Shale.

This shale is black, argillaceous, bituminous and rather friable and varies in thickness from one inch to forty or fifty feet. It immediately overlies the Silurian beds and is apparently unconformable with them since the shale lies on cherts and saccharoidal sandstones along Spavinaw creek and Illinois river, while about twenty-five miles farther south it lies on higher strata composed of one hundred and fifty feet or more of Silurian marble. Similarly, in Arkansas, the shale lies on top of the St. Clair marble and the Izard limestone along the southern border of the Silurian area, while farther to the north it rests on cherts and saccharoidal sandstones which underlie the marbles and limestones.

The shale is apparently conformable with the overlying beds, since the limestone at the base of the Boone chert was found resting on it at every place where it was seen. The shale may be seen at nearly every locality where Silurian beds are exposed, and at a few places where the erosion has not passed through the shale bed. Quite often detritus from overlying rock beds covers and obscures the outcrop of the shale, but by tracing the horizon a short distance it is usually found.

The Eureka shale has a wide distribution outside of the Indian Territory. It is usually found in northwestern Arkansas wherever the base of the Boone limestone is exposed. From its typical development at Eureka springs, Ark., it was named by Dr. J. C. Branner, the Eureka shale.[1]

Dr. Branner says: "The Eureka shale is clearly the equivalent of the Tennessee bed called by Safford the 'Black shale.'"[2] Safford says this shale also occurs in Virginia, Georgia and Alabama.[3]

[1] *Ann. Rept. Geol. Sur. Ark.*, Vol. iv, 1890, p. 345; "Phosphate Deposits of Ark.," *Tran. Am. Inst. Min. Eng.*, 1896, xxxvi, 580–582.

[2] *Ann. Rept. Geol. Sur. Ark.*, Vol. iv, 1888, p. 26; "The Phosphate Deposits of Arkansas," *Trans. Am. Inst. Min. Eng.*, 1896, xxxvi, 582.

[3] *Elementary Geol. of Tenn.*, by James M. Safford and J. B. Killebrew, Nashville, 1885, p. 75.

The "Black shale" of Tennessee was referred to the Devonian[1] by Safford. The Eureka shale of Arkansas was referred doubtfully to the Devonian.[2] Dr. Branner thinks the shale belongs to the Lower Carboniferous,[3] because in places it grades into the overlying Lower Carboniferous limestones, and the few fossils that have been found in the shale belong equally to the Devonian and the Lower Carboniferous. The persistency with which such a thin bed occurs unconformably with the Silurian and conformably with Lower Carboniferous beds in the Territory, as well as in Arkansas, also strengthens the theory that it is Lower Carboniferous.

Spavinaw Creek Area.—Exposures of the shale are common around the border of the Silurian area on Spavinaw creek. One of the best exposures seen there was about one mile west of Spavinaw post-office, on the north side of Spavinaw creek. At that point it is about forty feet thick, and is the usual typical, bituminous, rather friable shale.

Illinois River Areas.—On the north side of the Illinois river, west of the Cincinnati-Siloam Springs road, and near the Arkansas-Indian Territory line, good exposures of the shale may be seen. Near the Stewie ford of the Illinois river, along the Cincinnati-Oaks road, the shale outcrops again. In the limited area examined, no complete section was seen, but it appeared to have its usual thickness and characteristics. West of Bunch, at a point about four miles below the mouth of Elk creek, the Eureka shale outcrops in the bed of the Illinois river.

Salisaw Creek Areas.—About two miles northwest of Bunch, along Marble creek, the valley shows the typical Eureka shale soil, but no good exposures of the shale were seen there. Along Walkingstick creek, however, about three and a half miles north of Marble, good exposures of the shale may be seen. At this locality it is about thirty feet thick and contains some calcareous nodules, otherwise it does not vary from its general characteristics. Along Dry creek, one and a half miles northwest of Marble, good exposures of the shale show it to be about thirty feet thick.

[1] *Elementary Geol. of Tenn.*, by James M. Safford and J. B. Killebrew, Nashville, 1885, pp. 112, 118.

[2] *Ann. Rept. Geol. Sur. Ark.*, 1891, Vol. ii, p. 32.

[3] "Phosphate Deposits of Arkansas," *Trans. Am. Inst. Min. Eng., loc. cit.*

Boone Chert and Limestone.

Stratigraphic Position.—Immediately above the Eureka shale, there is a series of cherts and limestones aggregating from fifty to about five hundred feet in thickness, and averaging about three hundred and fifty feet. It was named the Boone chert by Dr. Branner because of its extensive and typical development in Boone county, Ark.[1] These beds are the probable equivalents of the Burlington-Keokuk divisions of the Lower Carboniferous.

Areal Extent.—The Boone chert and limestones form the principal strata outcropping over several counties in southwest Missouri and northwest Arkansas, and continue into the Territory, where they cover half of the Cherokee Nation—three thousand square miles. They lie in the northeastern and east central part of the Cherokee Nation. Roughly, their western limit is four to five miles west of Grand river and their southern limit some twenty to twenty-five miles north of the Arkansas river. Tracing the boundary more definitely, it enters the Territory south of Baxter Springs, Kans., curves to the southwest, passing through Miami, thence bears southward to near Fairland, whence it extends southwestward to a point on the M. K. & T. Railway, some four or five miles southwest of Vinita. From this point it runs southward in a wavy line between the railway and Grand river to a point about fourteen miles north of Ft. Gibson. From this point it runs eastward in a zigzag way to a point about one and a half miles south of Tahlequah. Then in its eastward course it swings southward, passing a little south of Park Hill, makes deep southward swings on the Illinois river, Salisaw and Lee's creeks, and passes into Arkansas a little north of Evansville. All along this border, and more especially its southern part, there are small isolated areas of higher geologic horizons scattered over the chert area along drainage divides.

Structure.—Over most of this area the beds are practically horizontal, but nearer the borders the strata dip toward and at right angles to the border line. In the northwest part of the area this dip, even along the border line, is barely perceptible, but toward the south the dip increases and also becomes more irregular by the increased folding and some faulting along several axes. These disturbances largely account for the irregular border of the chert area on the southwest and south.

[1] *An. Rep. Geol. Sur. Ark.*, 1890, Vol. i, p. 129.

Stratigraphy.—Most of the formation is chert, and the limestone strata are usually confined to the base and top of it. These two limestone horizons are usually five to twenty feet thick each. The limestone interstratified with the chert is in thin layers, seldom more than two or three feet in thickness, and is of rather rare occurrence.

Characteristics of the Chert.—The chert varies in color from white to gray; light gray or white is the prevailing color, and is especially characteristic of the rock that has been exposed to weathering agencies, or is dry. Weathered pieces, however, are often of a brownish color. The rock is almost a uniform mixture of lime and silica, but the proportion of lime and silica varies somewhat at different horizons or even along the same stratum. In weathering it breaks into rather small sharp angular pieces. The strata are usually thin and present a slight wavy and much fractured appearance. These features are doubtless due to the weathering of rock of an uneven composition. These irregularities and characteristics run through the whole chert bed throughout the entire area.

Limestones.—The limestone at the base of the chert bed corresponds to the St. Joe marble of the Geological Survey of Arkansas;[1] it varies from an inch to about thirty feet in thickness; it is of rather uniform texture, quite crystalline, of a rather dark-gray color, and lies in strata from a few inches to four or five feet in thickness. This bed is rarely missing where the base of the Boone chert was seen. On Spavinaw creek and Illinois river it is from fifteen to twenty feet thick. On Dry creek, one and a half miles northwest of Marble, it is about two feet thick, crystalline, gray in color, and contains greenish specks scattered through it.

The limestone that occurs very sparingly through the chert is rarely more than two or three feet thick. It is usually of uniform texture, tough, and of a gray color.

The limestone at the top of the chert is from fifteen to forty feet in thickness. It is massive, tough, gray and crystalline, but in the northwestern part of the area it is arenaceous and somewhat flaggy. This limestone forms the base of a great many small hills along the border of the chert area. It is often marked by glades due to thin soil. Along the west bank of Spring creek, near the south line

[1] *Ann. Rept. Geol. Surv. Ark.*, 1890, Vol. iv, p. 253.

of the Quapaw Nation, hard gray massive beds of the upper Boone limestone are finely exposed in bluffs and benches known as the Devil's Promenade. Along the east bank of the Neosho river, south and southwest of Miami, the upper Boone limestone forms a long outcrop; the bed is composed of shaly, flaggy and lenticular bedded limestone, some of which near the top and especially along parting planes is decidedly arenaceous. Archimedes are abundant in the upper part of these limestones. Along a little brook, one mile to the west of Big Cabin creek, a full section of the limestone overlying the Boone chert is exposed. The limestone bed is about thirty feet thick and arenaceous throughout, though it varies very much in the proportion of sand and lime in different strata. The beds that are most arenaceous are shaly and lenticular and some contain arenaceous limestone nodules with flinty centres. Archimedes occur in some of these strata. East of Grand river, opposite Chouteau, this bed is arenaceous and flaggy. About seven miles east of Adair the Boone limestone outcrops along streams. The rock is massive, hard, gray, fossiliferous limestone. The outcrops seen northeast of Ft. Gibson, west and southwest of Tahlequah, are practically all gray limestone in rather massive strata. The bed as it occurs along the Illinois river and Greenleaf creek southeast of Greenleaf, is about thirty feet thick, mostly gray and massive limestones. There is at the top of the bed, however, a stratum of bluish limestone which weathers to a whitish color, and the base of the bed is somewhat arenaceous, shaly and wavy.

Along Walkingstick creek, about three miles north of Marble, the stratum is thirty feet thick, and is composed of massive gray limestone. The top of this bed, as seen in the base of a hill one and a half miles south of the Tahlequah-Evansville road and four or five miles east-southeast from Wauhillau, has a little blue limestone that weathers white. Near the base it is decidedly arenaceous and shaly; the rest of the bed, which is the greater part of it, is massive gray limestone as usual. East of Stillwell, south and southwest of Westville, the stratum is from thirty to forty feet thick, and is practically all gray limestone in layers from a few inches to five or six feet in thickness.

Fayetteville Shale.

The Fayetteville shale is probably the stratigraphic equivalent of the Warsaw division, as recognized in Illinois, Iowa, etc.

Secs. a–k, Pl. V, show the variation in thickness and the associated strata of the Fayetteville shale along its line of outcrop through the Indian Territory. These sections were made at the following localities:

Sec. a—About two miles west and southwest of Stillwell.

Sec. b—Four or five miles east-southeast from Wauhillau and one and a half miles south of the Evansville-Tahlequah road.

Sec. c—Compiled from sections made northwest of Marble and southwest of Bunch.

Sec. d—West side of Big Vian creek about one and a half miles northwest of Vian.

Sec. e—Compiled from outcrops along the Illinois river and Greenleaf creek, about five miles east-southeast from Greenleaf.

Sec. f—About one mile north of Fourteen Mile creek and one and a half miles northeast of Grand river.

Sec. g—About two and a half miles south-southwest of Markhain's store or thirteen miles south of Brushtopped mountain.

Sec. h—One and a half miles east of Grand river, opposite Ned Adair's ferry, east of Chouteau.

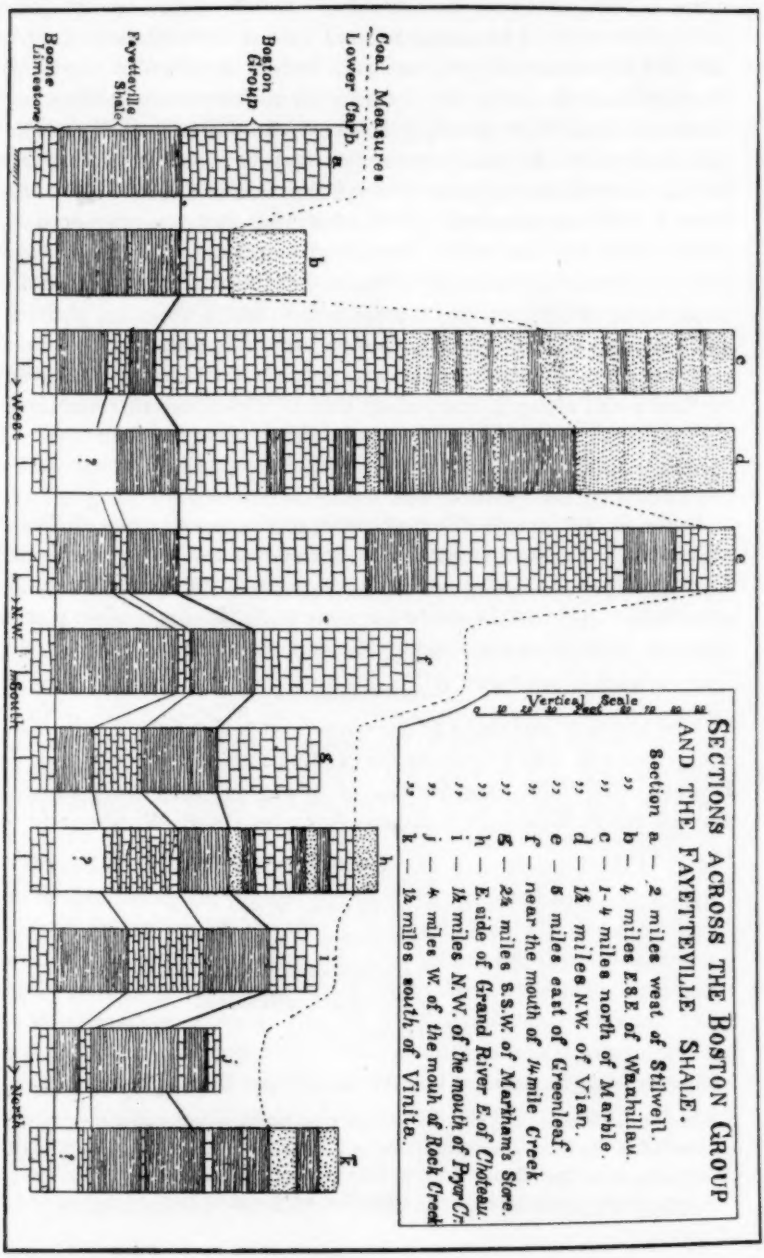
Sec. i—Brushtopped mountain, a small hill one mile north of Pryor creek and one and a half miles west of Grand river.

Sec. j—South side of Rock creek about four miles west of its mouth northeast of Adair.

Sec. k—Along and south of Little Log Cabin creek one and a half miles south of Vinita.

The Fayetteville shale is a black, friable, clay shale, which usually contains clay-ironstone concretions, and has an average thickness of about fifty feet. This shale immediately overlies the upper Boone limestone, and varies but little around the southern and the southwestern border of that limestone, and also along the western border as far north as the Grand river east of Chouteau. Farther to the northward it is more arenaceous and thinner and varies in color from gray to blue and yellowish. It is doubtful whether there are any outcrops as far north as the Indian Territory-Kansas line that may be referred to this shale. The shale is divided throughout by a bed of light blue, friable, fine-grained lime-

Plate V.



SECTIONS ACROSS THE BOSTON GROUP AND THE FAYETTEVILLE SHALE.

Section a — 2 miles west of Stilwell.
" b — 4 miles E.S.E. of Wauhillau.
" c — 1-4 miles north of Marble.
" d — 12 miles N.W. of Vian.
" e — 8 miles east of Greenleaf.
" f — near the mouth of 14-mile Creek.
" g — 2½ miles S.S.W. of Markham's Store.
" h — E. side of Grand River E. of Choteau.
" i — 12 miles N.W. of the mouth of Pryor Cr.
" j — 4 miles W. of the mouh of Rock Creek.
" k — 12 miles south of Vinita.

stone. The lithologic characteristics of this limestone are quite uniform throughout its extent and are such as to contrast it sharply with the limestones of the associated beds. It varies in thickness from an inch to thirty feet. Along Grand river east of Wagoner, Chouteau and Pryor creek, it is twenty to thirty feet thick; farther northward and southeastward it is usually but five to ten feet thick. This bed is apparently confined to the Indian Territory, since it was not observed north of Vinita and was not noted in Arkansas by the Geological Survey of that State. There is, however, a stratum of limestone about a foot thick in the Fayetteville shale three miles southeast of Westville, which from its position and lithologic characteristics, appears to be this bed.

In the Fayetteville shale exposed around the hillsides southwest of Bunch and along Illinois river east of Greenleaf this limestone occurs almost regularly and is usually five or six feet thick.

Batesville Sandstone.

In the isolated small hills northwest, southeast and south of Westville, sandstone beds twenty feet or more in thickness overlie the Fayetteville shale, and are probably the equivalent of the Batesville sandstone. This sandstone bed is apparently lacking at other places over the field where the Fayetteville shale was seen.[1]

Boston Group.

This group is composed of the uppermost beds of the Lower Carboniferous and corresponds to the St. Louis and Chester horizons of Illinois, etc. The classification of the group into beds as was worked out in Washington county, Ark., by Dr. F. W. Simonds[2] is as follows:

Boston group	Kessler limestone.
	Coal-bearing shale.
	Pentremital limestone.
	Washington shale and sandstone.
	Archimedes limestone.
	Marshall shale.

These horizons were classified mainly on lithologic characters,

[1] Mr. Stuart Weller has recently shown that the Batesville sandstone is the equivalent of the Aux Vases sandstone of Illinois and Missouri (*Trans. N. Y. Acad. Sci.*, xvi, 251–282).

[2] *Ann. Rept. Geol. Surv., Ark.*, 1888, Vol. iv, p. xiii.

which change rapidly in most of them. These variations are apparently greater in the Indian Territory than they are in Arkansas. In the northern part of the Indian Territory it is doubtful whether the group is represented by any deposits of consequence. It is represented southeast of Vinita by a series of shaly clays and thin beds of impure limestones, aggregating about seventy-five feet in thickness. East of Chouteau, along Grand river, the group is about one hundred feet thick and is rather clearly divided into different beds of limestones and shales. On Salisaw creek and eastward to the Arkansas-Indian Territory line, the group is about one hundred and fifty to two hundred feet thick. The whole group, as outlined in Washington county, Ark., is, however, nowhere in the area studied represented in a characteristic way. The Archimedes and Pentremital limestones are usually together, and it is very doubtful whether the Kessler limestone is at all represented.

This group is usually confined to an escarpment and isolated hills along the western and southern border of the Boone chert and limestone area; at most its outcrop forms a belt only two or three miles wide along the border of the Lower Carboniferous. Secs. a–k, Pl. V, show the development of this group along its line of outcrop from near Stillwell to near Vinita. The hills east, west and south of Stillwell are capped by fifty to seventy-five feet of limestone that belongs to this group. The limestone is usually gray in color, rather massive and in places quite arenaceous. Farther westward, in the isolated hills south of Wauhillau, near the Evansville-Tahlequah road, the limestone and beds of the Boston group are considerably thinner and are overlain by sandstone that is probably Coal Measures. Ten to twenty-five miles south and southwest of Wauhillau, near Bunch, Marble, Vian and along Illinois river east of Greenleaf, the Boston group is one hundred and fifty to two hundred feet thick and probably thicker, since the dividing line that has been used to separate this group from the Coal Measures is largely an arbitrary one and the doubtful beds are mostly classified as Coal Measures. One and a half miles northwest of Marble the lower part of the Boston group beds consists of about one hundred feet of gray limestone slightly interstratified with clay shale and arenaceous shaly limestone. Archimedes occur frequently in the lower part of the limestone bed. Overlying this limestone there is a series of strata aggregating about two hundred feet in thickness, which are composed of sandstones and some interstratified clay shale.

The sandstones vary from massive to flaggy and shaly, and in places near and at the top they grade into a grit. This grit appears to be the equivalent of the so-called Millstone grit of the Geological Survey of Arkansas, since it has the same lithological characteristics and apparently has the same stratigraphic position. It is probable, therefore, that not over one hundred feet of the shales and sandstones overlying the limestones at this place should be referred to the Boston group. The above section (Sec. c, Pl. V), with slight modifications, represents the group as it is shown in outcrops between Bunch and Marble.

The Boston group is well exposed along the west side of Big Vian creek, northwest of Vian, where Sec. d, Pl. V, was made. The section at that place is as follows:

	FEET.
Massive sandstones (Coal Measures ?)	100+
Arenaceous black clay shale	75
Brownish, weathering, hard limestone	½
Shaly sandstone	5
Gray, massive, hard limestone	5
Black clay shale	10
Massive, hard, gray limestone at the base which grades into shaly brownish weathered limestone at the top	15
Clay shale (?)	10
Massive, gray, firm, fossiliferous limestone	35
	135½

The following is a section on the east side of Illinois river, about west-northwest of Marble:

	FEET.
Sandstone and grit (Coal Measures?)	30+
Blue clay shale	5
Uniformly textured, smooth, gray limestone in strata 1 to 2 feet thick	10
Nodular friable limestone in thin, irregular, rough-surfaced strata with clay partings and fillings of lenticular places through the strata	10
Rather uniformly textured, massive, gray, fossiliferous limestone	50
Blue clay shale	20

	FEET.
Hard, gray limestone	2
Sandstone and clay shale	10
Limestone, usually massive, arenaceous, and friable, but it varies to pure, tough limestone of a gray color. Some bluish limestone, which weathers to a white color, occurs near the base of the bed	30
	137

Below this section is about twenty feet of the Fayetteville shale and its included stratum of blue limestone. The limestone at this place is only about two feet thick.

On the west side of Illinois river, about five miles east-southeast from Greenleaf, the following section (Sec. c, Pl. V) may be seen:

	FEET.
Sandstones and grit (Coal Measures?)	at top
Massive, gray, brownish weathering limestone	15
Clay shale	20
Massive gray limestone	4
Blue limestone alternating with a little clay shale. The limestone weathers to a rather smooth but angular wavy surface and a whitish or yellowish color; the weathered cross sections of fossils and wavy branching calcite seams of a darker color than the mass of the rock gives a streaked, wavy and mottled appearance to its surface	30
Rather massive but in part flaggy limestone which in places contains abundant Pentremites	50
Clay shale	25
Gray massive limestone	75
	215

The following section is exposed four miles southeast of Ft. Gibson on the south side of Bayou creek along the Ft. Gibson-Braggs road:

	FEET.
Sandstone (Coal Measures)	at top
Massive gray limestone	10

	FEET.
Argillaceous sandstone, sandstone shale and arenaceous clay shale	20
Limestone: the lower part is brownish weathering and somewhat shaly, the upper part is massive and gray	20
Sandstone	5
Limestone	5
Sandstone	5
Limestone containing Archimedes in the central part of the bed	50
	115
Fayetteville shale and some interstratified blue limestone	at base

West and northwest of Tahlequah, along Pecan creek and Fourteen Mile creek, and along Grand river, east and northeast of Wagoner, the Boston group is usually limited to a fifty to seventy-five foot bed of limestone, which is in places slightly interstratified with clay and contains Archimedes and Pentremites associated throughout almost the entire bed. The Archimedes, however, are more common in the central and lower divisions, while the Pentremites are more common in the central part of the bed. Farther to the north it becomes thinner and more argillaceous until calcareous and arenaceous clays form the principal part of the group as shown in Secs. j and k, Pl. V. East of Pryor creek, Adair, Big Cabin, and south of Vinita, the group is represented by yellowish calcareous clays, friable arenaceous limestones, some hard gray limestone and a little sandstone. The limestone and clays are usually rich in fossils. The following section (Sec. k, Pl. V) will show the general character of the group along its outcrops from the Grand river, east of Chouteau, to within one and a half miles of Vinita.

	FEET.
Brownish weathering massive sandstone (Coal Measures?)	5
Clay shale (Coal Measures?)	10
Sandstone (Coal Measures?)	12
Coal Measures	27

	FEET.
Clay shale which contains some fossiliferous shaly limestone near the base	10
Friable arenaceous fossiliferous limestone	2
Calcareous, fossiliferous, yellowish clays	10
Hard, rough-surfaced, highly fossiliferous limestone	3
Bluish clay shale	25
Limestone	1
	51
Clay shale (Fayetteville shale?)	at base

Fossils of a decided Coal Measures facies were collected from some black clay shale at a place on the M. K. & T. Railway, about four miles north of Vinita. This shale is not more than one hundred and fifty feet above the Boone limestone, so the strata referable to the Boston group, at this place, is probably not more than twenty-five or fifty feet thick.

Between Fairland and Miami the strata that may be referred to this group are gray shales and possibly a little limestone. Northeast of Miami it seems probable that the horizon of the Boston group is overlapped by Coal Measures shales and sandstones, or if this is not the case the group is represented by gray clay shales and some sandstone.

The sections of the Boston group show that it is thicker and apparently has higher beds in the southwestern part of the Lower Carboniferous area where the strata are exposed by being folded or excessively eroded. The same sandstone or grit bed appears to overlie unconformably these different Lower Carboniferous beds at various places. The sandstone beds lying on the Boston group one and a half miles south of Vinita are apparently the same sandstones that rest on the Boone limestone, some six or seven miles southeast of Vinita. Two or three miles southwest from the mouth of Pryor creek a conglomerate sandstone overlies the Boston group to the westward and the Boone limestone to the eastward. The gradual upward change in the Lower Carboniferous deposits from massive and extensive cherts and limestones to shales, arenaceous limestones and sandstones indicate an upward movement of the ocean bottom. This movement may have continued

until the deposited beds were subject to slight erosion before the following subsidence began and the sand and grit deposits laid down over them. The continuity of the fauna and the small amount of overlapping in these deposits could, however, allow only a slight break in deposition.

Coal Measures.

The Coal Measures of the Indian Territory and Oklahoma are a direct continuation of the Kansas, the Arkansas and apparently the Texas Coal Measures. The southward extension of the Coal Measures of Kansas enters the Indian Territory in a belt sixty-five miles wide, which extends from about ten miles west of the northeast corner of the Territory to near the northwest corner. The western limit of this belt through the Territory bears about 10° west of south throughout the area studied. The eastern limit running southward from the Kansas-Indian Territory line extends south 40° W. for a distance of forty miles, then runs nearly south for fifty miles and then with a gentle southward curve and zigzag line extends eastward into Arkansas. The belt through the Territory, therefore, at first contracts from the eastern side for a distance of nearly one hundred miles, then rapidly widens on the eastern side so that the Coal Measures in the territory studied, roughly covers an L-shaped area. The southward continuation of the Coal Measures into Texas is broken in the southern part of the Indian Territory by the overlapping of Cretaceous deposits.

Structure.—The Coal Measures lie in the three structural and topographic groups previously mentioned. The horizontally uplifted plateau, or Ozark type, includes the larger part of the Coal Measures lying between the southern boundary of the Lower Carboniferous area and the northern boundary of the Arkansas river valley. The area of the folded beds, or Ouachita type of structure, lies principally south of the Arkansas river and east of a line connecting the mouth of the Canadian river, Brooken, and a point about seven miles west of McAlester. The remaining and by far greater part of the Coal Measures in the area under discussion belongs to the Prairie Plains region, and consists of gently westward and northwestward dipping strata.

Stratigraphy.—With the possible exception of slight uncomformities produced by overlapping of the basal beds of the Lower Coal Measures, there seems to be no break in the stratigraphy from Lower

Carboniferous into Permian beds. A rough estimate gives a total thickness of 25,000 feet for the Coal Measures deposits. Most of these strata were laid down near shore and are, therefore, subject to the irregularities of near-shore deposits. Arenaceous clay shales, sandstones, limestones, coal, grits and conglomerates occur in relative abundance in the order named. Well-marked beds that may be used for making stratigraphic divisions are for the most part wanting. The limestone beds are mainly confined to the northern part of the field and to the central part of the Upper Coal Measures. The shale and the sandstone beds are so local and repeated in such lithological uniformity that they serve poorly for divisions; fossils, especially in the southern part of the field, are of rare occurrence. The larger coal beds, with some irregularities, extend across the entire field and furnish the best means of grouping the formations. The workable beds of coal are all confined to the lower part of the Upper Coal Measures. The Coal Measures deposits will be considered under the following classification:

Coal Measures.
- Upper Coal Measures.
  - Poteau group.[1]
  - Cavaniol group.[1]
- Lower Coal Measures.

Plates II and VII show the relation of these groups.

The Lower Coal Measures produce no coal; the Cavaniol group contains the workable beds, and the Poteau group contains some thin ones.

Lower Coal Measures.

There are three different areas of the Lower Coal Measures in this field. One lies in the southeastern part of the region, and is bounded on the north by a line running along the southern base of the Poteau mountains and the north side of Fourche Melane valley and Jack Fork mountains; from the latter place the bounding line runs southwesterly and passes out of the field. This area includes the Fourche Melane valley and the upper part of the Kiamichi valley and Walker, Black Fork, Rich, Blue, Windingstair, Jack Fork and Kiamichi mountains and the intervening areas.

[1] These names were taken from the names of mountains in the southeastern part of the field where the beds included in those groups are well represented.

The second area is a strip about four miles wide and twenty-two or twenty-three miles long which extends into the Territory along the Backbone anticline. The third one is an irregular belt bordering the Lower Carboniferous on the south and west. The most of the southern part of this belt lies near and to the north of the Arkansas river, and includes the Boston mountains; the western part of the belt extends along the Missouri, Kansas and Texas railway from Wagoner to Vinita, and from Vinita it runs northeasterly, passing into Kansas at and southwest of Baxter Springs. Along the Arkansas-Indian Territory line this belt is about twenty miles wide, but it gradually narrows to the westward and northwestward until north of Wagoner it is usually but four to five miles wide.

Lithology of the Lower Coal Measures.—Throughout this group there is such a constant repetition of arenaceous gray, clay shales and sandstones of uniform character that the lithology and stratigraphy are exceedingly monotonous.

There is, however, some marked variation introduced by the grits and conglomerates at the base of the group north of the Arkansas river, and by the limestones south of Ponola, Wilburton and Hartshorne. Some minor variations in color and composition also occur in the shales and sandstones. The sandstones are usually massive, but in places they are flaggy or shaly and micaceous, argillaceous, calcareous, ferruginous, or bituminous. A little quartzite occurs in the Windingstair mountains and some conglomerates may be seen in the vicinity of Thomasville.

Thickness of the Lower Coal Measures.—The greatest thickness observed in the Lower Coal Measures was in the southeastern part of the field. In this locality the strata throughout show little variation; extensive faults lie along the north side of Walker, Black Fork, Windingstair and Kiamichi mountains, and smaller faults at other places; and overthrows occur at some places to further complicate the interpretation of the stratigraphy. On account of these difficulties, as well as the limited amount of work the reconnaissance would allow, only rough estimates of the thickness of the exposed beds will be attempted.

The longest continuous section studied in this part of the field was from the base of the Poteau mountains to the south side of Rich mountains. This section extends north and south about three or four miles west of the Arkansas-Indian Territory line. The stratigraphy somewhat generalized along this line is shown in

Sec. 8 (p. 366.) The strata exposed along this section are divided into three divisions by two faulted areas. The division on the north is about seven thousand feet thick, the one next further to the south is about eleven thousand feet thick, but possibly contains as much as six thousand feet of strata that is repeated from the first division, thus leaving only five thousand feet to be added to the seven thousand of the first division, which gives twelve thousand feet. The third and last division is about fifteen thousand feet thick. In this the heavy sandstone beds in the south side of Black Fork and Rich mountains are each about one thousand feet thick, and are so much more massive than any of those exposed to the north, that they are probably lower horizons. There is a strong probability, however, that the strata of Black Fork and Rich mountains are the same, which is the case if the beds are overthrown to the north, as they appear to be. If this is the case, only five thousand feet of the thickness of the strata of the two mountains, should be added to the section already estimated. The remaining five thousand feet of strata to the north of Black Fork mountain is most likely a repetition of the strata exposed and counted farther to the northward. So only five thousand feet more can safely be added to the twelve thousand feet, which gives a total thickness of seventeen thousand feet.

It is possible that this section represents a thickness of as much as twenty-five thousand feet of strata, but under the observed conditions, seventeen thousand feet seems more probable, and even that may be too much. The base of the formation was not seen, but as the thickness exposed is very nearly as much as the estimated thickness of the whole formation in Arkansas,[1] it is probable that almost the total thickness of the beds is exposed in this section. The Lower Coal Measures in Arkansas, however, run a little higher in the section than they do in the Indian Territory, since the Huntington Coal belongs to a higher horizon than the coals farther to the east in Arkansas.[2]

Stratigraphy of the Lower Coal Measures.—The basal beds of the Lower Coal Measures appear to be exposed only in the Cherokee Nation. Overlying the Lower Carboniferous there is a series of sandstones, grits and shales which belong to the basal beds of

[1] Dr. Branner estimates the thickness of these Lower Coal Measures in Arkansas to be 18,480 feet thick (*Amer. Jour. Sci.*, Vol. ii, September, 1896, p. 235)

[2] *Geol. Surv. of Ark.*, Ann. Rep., 1888, Vol. iii.

the Coal Measures. No definite division between the Lower Carboniferous and the Coal Measures could be fixed, but the fossils found in the highest strata, known to belong to the Boston group, are a mingling of species belonging to the highest Lower Carboniferous and the Coal Measures. These sandstones, grits and shales have the same lithological characteristics and stratigraphic position as the so-called Millstone grit of the Geological Survey of Arkansas.[1] There is every gradation from the smooth, fine-grained sandstones to the grits and coarse conglomerates. Good examples of the grit may be seen, north of Camp Track, five miles south of Bunch, in places three to four miles northwest of Vian, and along the east side of Illinois river west-northwest from Marble. This grit is composed of angular grains of quartz, which are usually from one to two millimetres in diameter, but occasionally are from five to six millimetres in diameter. Hematite usually forms the cementing matter for the grit. The basal group of the Lower Coal Measures in the Cherokee Nation is composed mainly of sandstones and grits throughout. No section was made of this group along the Arkansas-Indian Territory line, but it is probably not less than two thousand feet thick. Five to ten miles southeast of Ft. Gibson it is three hundred feet thick; from eight to ten miles northeast of Ft. Gibson it is about two hundred feet thick. From this place further to the north it rapidly thins until from about ten miles north of Wagoner to near Baxter Springs, Kans., it is but five to fifteen or twenty feet thick. In this northern part of the field the grit is usually lacking and the sandstones are very variable. These basal sandstones cap the isolated hills and east-facing escarpments from four to six miles south of Chouteau, one and a half miles south of Vinita, three miles west of Afton, one mile south of Miami, and about two miles south of Baxter Springs, Kans. There is a bed of gray, arenaceous clay shale two hundred and fifty to three hundred feet thick overlying this group of sandstones and grits throughout the Cherokee Nation. This shale is somewhat thicker in the northern part of the field than it is toward the south. It comprises nearly all the Lower Coal Measures strata that lie west of Grand and Spring rivers and throughout that area it is marked by level or gently undulating prairie plains.

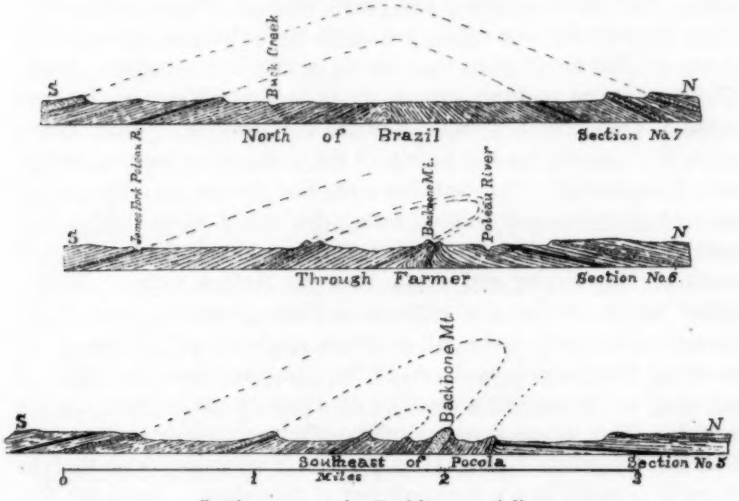
The southern extension of the Lower Coal Measures area of the Cherokee Nation outcrops along the Milton-Bokoshe anticline

[1] *Ibid.*, Vol. iv, p. 106, and 1890, Vol. i, pp. 113–115.

south of the Arkansas river. The rocks exposed along this anticline are mainly sandy clay shales north of Bokoshe, and massive and flaggy sandstones east and west of Milton. The sandstones one mile south of Bokoshe are highly micaceous and often smooth-surfaced flags. About two thousand feet of Lower Coal Measures rocks are exposed on either side of the anticline in this locality.

In the Backbone mountain area of the Lower Coal Measures the beds are massive sandstones and thick gray arenaceous clay shales. The sandstone beds are from about thirty to five hundred feet in thickness and the interbedded shales are from eight hundred to thirteen hundred feet in thickness. The structure of the Backbone ridges that best account for the observed facts is shown in Secs. 5, 6 and 7, Pl. VI and in Pl. I. This overthrown anticline is faulted

Plate VI.



Sections across the Backbone anticline.

along the north side of the overthrow. The faulting runs westward from Arkansas almost to the western end of the mountains, where it ends rather suddenly. With the gradual lessening of the faulting toward the west the strata on the north side of the fault line increase in dip as they approach the axes of the anticlinal folds. The thickness of strata exposed in this area, on either side of the anticline, is a little over twenty-five hundred feet. The Lower Coal Measures in the southeastern part of the field show very little

variation lithologically from the beds described to the northward; there is, however, a great increase in the thickness of the deposits. The east and west folding in this area has made it possible to get moderately long exposures of the same strata along the axial direc-

Sec. No. 8. Across the Lower Coal Measures, south of Poteau mountain.

tion of the folds. The three groups of strata shown in Sec. 8 are, with modifications, extended to the westward the full length of the area. The faulting along the north side of Walker mountains, along Fourche Melane valley and south of Hartshorne, separates the group on the north from the Central or Walker mountain group. The central and southern groups are in part repetitions of the same strata. The second group comprises the strata of Walker mountains, Blue mountains and nearly all the strata lying between Bengal and Hartshorne. The beds between Hartshorne and Bengal are referred to the second division rather doubtfully, since this necessitates an upthrow of about six thousand feet along the faulted belt south of Hartshorne and along Fourche Melane valley. Such a throw would require the strata in a block about one and three-quarter miles wide to be tilted at an angle of 45° to the south. South of Hartshorne, as shown in Sec. 10, the strata are tilted at angles of 40° to 50° for a distance of about two miles and possibly farther. This tilting is only slightly offset on the north side of the fault line by gentle dips of 4° to 5°. So it seems probable that the throw is as much as six thousand feet at this place. South of Wilburton and southwest of Red Oak the strata on the south side of the Fourche Melane valley do not dip very much more steeply than they do on the north side, and as the dips are in opposite directions the beds appear to be the same. They are, however, not the same, for the coal beds are not repeated on the south side of the valley. Furthermore, the strata are different lithologically, since limestones occur on the south side and may be traced westward to the limestone beds south of Hartshorne, which beds have been shown to probably belong six thousand or seven thousand feet below the

Grady coal bed. The third division comprises the strata of Black Fork, Rich and Windingstair mountains.

The highest bed of the Lower Coal Measures is a sandstone about one hundred and fifty feet thick, although varying in thickness from a few inches to three hundred feet. Mr. H. M. Chance calls it the Tobucksy[1] sandstone. This bed is especially important because it immediately underlies the Grady coal bed and makes a ridge

Sec. No. 9. Across the Winding Stair and the Kiamichi mountains, south of Hanson creek.

of considerable prominence almost all along its line of outcrops, so that the coal may be closely located by tracing the outcrop of this sandstone. It has an unusual persistence for a sandstone, outcropping as it does almost regularly over an area of one thousand square miles, and forming an unbroken ridge excepting at a few places where streams have cut across it, from about three miles northwest of Heavener to Hartshorne. This ridge is a very prominent topographic feature rising usually one hundred to three hundred feet above the surrounding country. South and southwest of Heavener and southwest and west of Milton, this bed is thick and makes ridges from one hundred to three hundred feet high. Where it is thick enough to make a prominent topographic feature it is shown so on the sketch map. The following are approximate sections of the upper part of the Lower Coal Measures as they occur in Secs. 8 and 5; the sections were made south and southeast of Heavener and across the Backbone anticline.

	SEC. 8. FEET.	SEC. 5. FEET.
Sandstone	200	50
Gray arenaceous clay shale	1000	1150
Massive sandstone	50	250
Gray arenaceous clay shale	660	600
Sandstone	30	35
Clay shale	1150	500

[1] *Trans. Am. Inst. Min. Eng.*, Vol. xviii, p. 659.

SEC. 8. FEET.

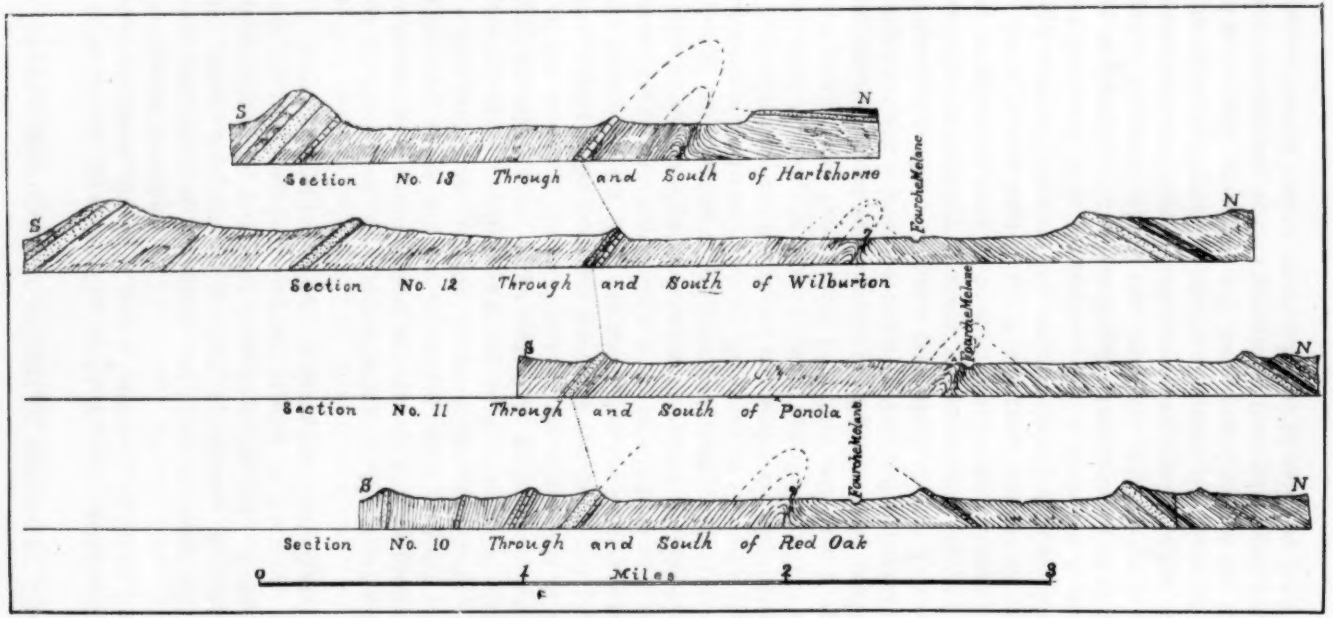
Sandstone	10
Shale and thin beds of sandstone	800
Sandstone	10
Shale and thin beds of sandstone	800
Sandstone	10
Shale and thin beds of sandstone	2000

The beds that appear to underlie these are those of Walker, Blue and Jack Fork mountains.

They are but little different lithologically from the beds above them, but the shales are of a darker color, and in the western part of the belt there is some limestone to break the usual monotony. The main ridges of Walker, Blue and Jack Fork mountains have sandstones from fifty to one hundred feet or more in thickness in the southern part of the ridges.

Secs. 10, 11, 12 and 13, Pl. VII, show the general character and variation of the rocks on the south side of Fourche Melane valley from a point south of Red Oak to a point south of Hartshorne. Sec. 10 lies south of Red Oak. The limestone, calcareous sandstone and arenaceous limestone shown in this section were seen southwest of Red Oak, but they probably extend farther to the east. In this section the first sandstone bed south of Fourche Melane is about one hundred feet thick, usually massive. Twenty to thirty feet of arenaceous limestone and calcareous sandstone occurs on the north side, or at the base of this sandstone bed. The next ridge to the south is formed by two sandstones each ten to fifty feet thick and separated by about fifty feet of clay shale. This shale southwest of Red Oak is partly replaced by five to ten feet of hard, rather nodular, blue limestone. On the north side of the fourth sandstone—the third prominent ridge south of Fourche Melane—there is more arenaceous limestone and calcareous sandstone. It is only five to ten feet thick at the places where it was seen. Farther west or south of Ponola, Sec. 11 shows the stratigraphy of the first ridge south of Fourche Melane. At this place the strata dip south 50°. There is a hard, blue limestone, fifteen to twenty feet thick, on the south side of the ridge; this limestone is underlain by about one hundred and twenty-five feet of sandstone, of which the upper fifty feet is ferruginous and fossiliferous, and the lower part is hard massive sandstone. This sand-

Plate VII.



Sections across the Fourche Melane valley.

stone is underlain by alternating strata of shaly sandstones and arenaceous clay shale, which in turn is underlain by thirty feet of gray fossiliferous limestone.

Farther west, south of Wilburton, only one limestone bed was seen, but others are probably covered by débris. A somewhat generalized section at this point is shown in Sec. 12. Farther to the west the limestone beds increase rapidly in thickness, until south of Hartshorne the lowest one is about one hundred and fifty feet thick.

Strata of Black Fork, Rich and Windingstair Mountains.—Massive sandstones with regular texture and smooth bedding planes and dark gray clay shales are the prevailing rocks of these mountains. The sandstones in the southern part of Black Fork mountain are about one thousand feet thick, principally massive, and light in color; some flaggy and shaly beds occur near the centre of the section. The sandstones of the south side of Rich mountain appear to be about one thousand feet thick and closely resemble those of Black Fork mountain, but are seemingly somewhat more flaggy and have a little more interbedded clay shale. The strata in the valley between the two mountains and those in the north side of both mountains are principally arenaceous clay shale and thin beds of sandstone. Along Big creek on the north side of Black Fork mountain, the sandstones and shales are distributed in the proportion of about one of sandstone to five of shale. The sandstones are usually from four to eight feet thick and have irregular bedding planes. About one mile east of Page a massive sandstone about fifty feet thick is broken across by a fault and so impregnated with bitumen that the rock has a very black color. There is a small anticline immediately southwest of this point in Big creek.

These irregularities seem to be only local breaks and crumplings on the side of a very large fold. Windingstair mountains appear to be the westward continuation structurally and stratigraphically of Black Fork and Rich mountains. Sec. 9 shows in a general way the stratigraphy of the Windingstair mountains south of Hanson creek. The north side of the mountains at this point is steep and rather free from ridges or cañons running parallel to the range, while the southern slope is broken by a number of ridges running parallel to the main mountain and less elevated toward the south. Deep erosion channels lie between some of these ridges and connect with a cross channel leading into the Kiamichi valley to the south.

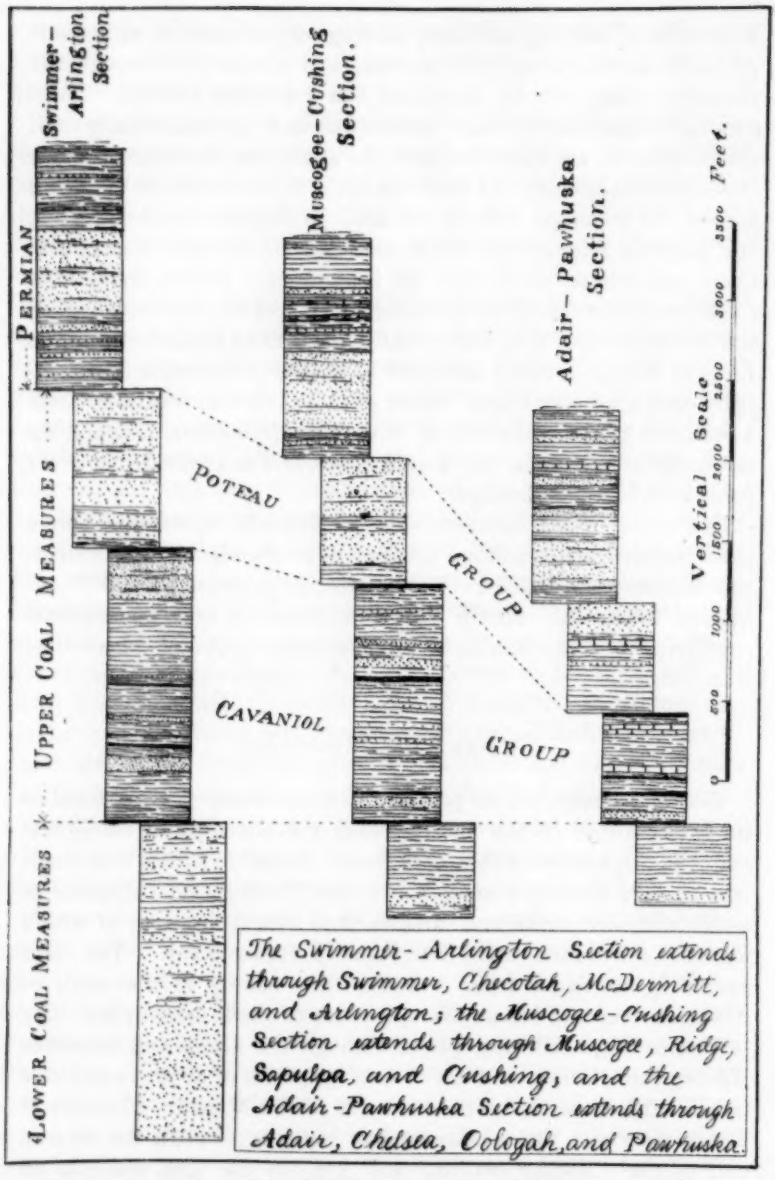
Evidences of faulting and sharp folding may be seen on either side of the mountain along this section, and almost all through the mountain along the St. Louis and San Francisco railway. These orographic movements have metamorphosed the rock locally until the sandstones are quartzites and the shales are hardened. Some limestone concretions and boulders occur in the shales on the north side of the mountain west of the head of Hanson creek and along the railroad four or five miles southeast of Bengal. Occasional chert concretions occur with the limestones. Porous, ferruginous sandstones were found in a number of places on the north face of the mountains and they were usually found to be fossiliferous. The rocks of Kiamichi valley southeast of Talihina appear to be principally dark gray clay shale. Some of this shale that was taken from a well dug at the south side of Windingstair mountain, about ten miles east of Talihina, was almost black and so crushed that every piece showed "slickensides."

The strata of the northern side of Kiamichi mountains bear a close resemblance to and are possibly to be correlated with the massive sandstones of Black Fork mountain, Rich mountain and Windingstair mountain. Sec. 9 shows the structure and approximate stratigraphy of the Kiamichi mountains at the point where they were studied.

Upper Coal Measures.

Cavaniol Group.—This part of the Coal Measures is confined to the area outlined on the map between the outcrops of the lowest and the highest workable coal beds. From Arkansas this coal-bearing belt extends westward into the Territory for a distance of about sixty-five miles and divides into two belts, one of which extends northward and the other southwestward. The belt extending westward from Arkansas lies mainly to the south of Arkansas river and has an average width of about forty miles. The belt extending northward passes through the Creek and Cherokee Nations into Kansas, and has an average width of about twenty-five miles. It lies mainly on the west side of the Missouri, Kansas and Texas railway. The southwest belt extends through the western part of the Choctaw Nation, and has, in the area studied, an average width of about fifteen miles. That part of the Cavaniol group lying to the south and east of Canadian river will be referred

Plate VIII.



Comparative sections of the Coal Measures. Compiled from cross-sections through the Cherokee, Creek and Osage Nations.

to as the Choctaw coal field,[1] since this term has been applied to that area by Dr. H. M. Chance.

Stratigraphy.—The beds of this group consist of shales, sandstones, coals and limestones. The shales comprise the larger part of the strata, but sandstones are very abundant, especially in the southern part of the field, while limestone beds are confined to the northern part. The workable coals are thicker in the southern region, but extend throughout the entire area. The group is thickest in the southeastern part of the field and thinnest in the northern part. The decrease in thickness appears to run regularly to the westward and northward. The most constant and easily recognizable horizons in this division are the coal beds. Three of these are thick enough over most of the field to work. Other thin beds occur locally, and one in particular that lies about one hundred feet above the central coal bed extends almost regularly throughout the field where its horizon occurs. The lowest workable coal varies in thickness from one and a half to six feet; this is the coal that Dr. H. M. Chance named the Grady coal.[2] It proves to be, without any reasonable doubt, the same bed as the one worked at Huntington, Jenny Lind, Hackett and several other places in Arkansas.

The next higher workable coal is the McAlester bed, which varies in thickness from about one and a half to four feet. The highest workable bed is the Mayberry coal, which also varies in thickness from one and a half to four feet. These three coal beds apparently extend throughout the entire area of the Cavaniol group, but north of the Canadian river there are four coal beds that are worked locally. These four beds were not studied in enough detail to correlate them throughout. The outcrops and stratigraphy noted in different sections across the group give some suggestions of correlation, as may be seen in Pls. I and VIII.

The following table shows a rough estimate of the distance between the coal beds at different places in the Choctaw coal field:

[1] *Trans. Am. Inst. Min. Eng.*, Vol. xviii, p. 653.

[2] *Ibid.*, 1890, Vol. xviii, pp. 1, 2.

Vertical Distance between the Grady and McAlester Coal Beds.

LOCALITIES.	FEET.
One mile east of Fanshaw	2500
Two miles east of Red Oak	2500
West of Cameron	2000
North of Brazil	2000
South of Milton	2000
North of Wild Horse Prairie	1300
East of Krebs	1000

Vertical Distance between the McAlester and Mayberry Coal Beds.

LOCALITIES.	FEET.
Cavaniol mountains	3000
Northeast end of Sans Bois mountains	2200
West end of Sans Bois prairie	1500

These estimates show a marked tendency throughout the whole division to decrease in thickness towards the west and northwest.

The following sections will show the general stratigraphy of the two lower coal beds and the intervening strata in the Choctaw coal fields:

	One mi. west Fanshaw.	West of Cameron.	South side of Buck Creek Prairie.	North side of Buck Creek Prairie.	Northwest of Wild Horse Prairie.
	FEET.	FEET.	FEET.	FEET.	FEET.
Coal	1½	1½	1½		1½
Shale		1200			
Sandstone		10			
Shale	200	100	200	200	300
Sandstone	25	10	200	25	50
Shale	2000	300	600	900	400
Sandstone	50	25	15	25	100
Shale	300	400	1000	1000	500
Coal	3	3	4	4	3

Two sandstones and three clay shale beds usually form the sequence of strata between the two lower workable coals. This prevailing condition is shown in the above sections. This usual sequence, however, is not constant, for in some places, as northwest of Alderson, only one sandstone intervenes, and in other places, such as west of Cameron, there are three. This table is not intended to show a strict correlation but rather a comparison.

The strata between the McAlester and Mayberry coal beds apparently are more diversified. In the Cavaniol mountains four thick sandstone beds alternating with clay shales intervene between the coals. Northwest of San Bois there are three intervening sandstones, while to the west of Sans Bois two sandstone beds intervene, and east of Brooken only one of prominence lies between the two coal seams. This shows a decrease in the number and thickness of intervening beds to the northwest. The intervening sandstone beds, especially those in Cavaniol and Sans Bois mountains, are usually from fifty to two hundred feet thick and are evenly textured strata that usually have smooth bedding planes, and vary from flaggy to massive sandstone. The first sandstone below the Mayberry coal is especially flaggy and smooth where it was seen on the east end and north side of Cavaniol mountain. The dark gray clay shales interstratified with these sandstones are from two hundred to five hundred feet thick. South of the Arkansas river a coal seam four to eight inches thick occurs almost regularly one hundred feet above the McAlester coal.

A rough estimate of the thickness and stratigraphy of the Cavaniol group north of the Canadian river, along a line running from McDermitt through Checotah and Starvilla to the mouth of the Canadian river, is as follows:

	FEET.	INCHES.
Coal	2	6
Gray, arenaceous clay shale	50	
Friable, shaly and massive sandstone and some clay shale	300	
Gray, arenaceous clay shale	500	
Sandstone	10	
Clay shale	25	
Coal		10
Clay shale	200	
Sandstone	25	
Clay shale	100	
Coal		8
Clay shale	50	
Coal	1	3
Clay shale	50	
Sandstone and some interstratified clay shale	100	
Clay shale	300	
Coal	1	6
Total thickness (approximate)	1700	

A section across the group along a line from Muscogee, through Ridge and Sapulpa to Cushing, is approximately as follows:

	FEET.	INCHES.
1. Coal (Mayberry coal?)	2	
2. Clay shale	100	
3. Sandstone	10	
4. Shale	50	
5. Thin strata of light gray, arenaceous, limestone and calcareous sandstone interstratified with gray calcareous clay shale	25	
6. Gray clay shale	100	
7. Friable, black, carbonaceous, clay shale, which contains near the top some limestone nodules one and a half feet in diameter. These limestone nodules are carbonaceous and black, but weather to a white color and contain numerous calcite seams running through the nodules	50	
8. Sandstone	25	
9. Clay shale	100	
10. Sandstone	50	
11. Clay shale	100	
12. Coal	1	6
13. Gray, arenaceous clay shale containing some thin sandstone strata which are ferruginous in places	500	
14. Coal		4
15. Clay shale	250	
16. Coal	1	
17. Clay shale	100	
18. Sandstone	25	
19. Clay shale	25	
20. Coal (Grady coal?)		8
Total thickness (approximate)	1500	

A section across the group along a line from Adair through Chelsea and Oologah to Pawhuska is as follows:

	FEET.
1. Coal (Maybery coal?)	2
2. Clay shale	100
3. Limestone (Oologah limestone[1])	50
4. Arenaceous clay shale and a little interstratified shaly sandstone	200
5. Gray limestone	15
6. Clay shale	5
7. Coal	1¼
8. Clay shale and sandstone	50
9. Limestone	2
10. Clay shale	50
11. Coal	1½
12. Clay shale and a little sandstone	150
13. Sandstone	25
14. Clay shale	15
15. Coal (Grady coal?)	1½
Total thickness (approximate)	650

These three sections show the Cavaniol group to have the following northward variations: A regular decrease in the thickness of the group and in the relative proportion of sandstones; a gradual increase in the limestones, and a very little variation in the coals. The most marked stratigraphic feature introduced in the northern part of this group is the limestone beds.

Bed 5 of the Muscogee–Cushing section is apparently the Oologah limestone, since it has about the same stratigraphic position and shows the decrease of limestone common to the southward development of the beds. At and in the vicinity of Oologah this limestone is massive, hard, gray, rather unevenly textured, and in places contains gray chert nodules. On weathering, the limestone breaks into irregular-shaped pieces. This bed forms an east-facing escarpment fifty to one hundred feet high along the west side of Verdigris river valley east of Oologah. The limestone bed next in

[1] This bed has been called the Oologah limestone because it is finely exposed in Oologah, along Four Mile creek at the west edge of Oologah, and in an escarpment some three miles to the east of that place.

importance to the Oologah limestone is Bed 5 of the Adair-Pawhuska section. This limestone is beautifully exposed in bluffs along the east bank of Verdigris river, quarter of a mile below the McClellan ford east of Talala. At that place it contains no chert nodules, but in other lithologic characteristics it closely resembles the Oologah limestone.

Poteau Group.—Dr. J. P. Smith was the first to introduce the name Poteau in connection with strata included in this group.[1] It is probable that the Poteau mountain beds do not extend so high as the base of the Permian, but the name "Poteau group" will be applied to the group of beds between the Cavaniol group and the base of the Permian, as outlined in this paper. The dividing line used to separate the Poteau group from the Permian is merely an arbitrary one, and is, in the main, based on the fossils found at different localities. The beds of the Poteau group lie in small isolated areas and in a long belt-like area. The isolated areas are the upper parts of Poteau, Sugar Loaf, Cavaniol, Sans Bois, Tucker Knob and McChar mountains. The long belt-like area lies on the west side of the Cavaniol group throughout the field and has an average width of fifteen to twenty miles. The beds of this area are tilted to the northwest, where they lie against the western limit of the folded region of the Choctaw coal field, but further to the north the beds dip gently to the westward or a little north of westward. Throughout this belt the outcropping hard rock beds form east and southeast facing escarpments.

The Mayberry coal bed was not definitely located in either the Sugar Loaf or the Poteau mountains, but as these mountains do not appear to be situated in quite such deep synclines as the Cavaniol or the Sans Bois mountains the coal must be at a somewhat higher elevation. All four of these mountains are nearly the same in elevation—between twenty-five hundred and three thousand feet. From fifteen hundred to two thousand feet of the upper part of the Cavaniol and Sans Bois mountains belong to the Poteau group and twelve hundred to fifteen hundred feet of the tops of Sugar Loaf and Poteau mountains belong to this group. The group northwest of McAlester is about two thousand feet thick, but probably the top beds represent somewhat higher horizons than the top

[1] *Jour. Geol.*, Vol. ii, pp. 194-196, and *Proc. Amer. Phil. Soc.*, Vol. xxxv, No. 152, p. 17.

beds of the above-named mountains, since the same strata decrease in thickness to the westward and especially to the northward. This group, in the main, consists of arenaceous gray clay shales and massive sandstone beds, but in the northern region limestone beds are included in the group. The sandstone beds of this group are somewhat more massive than they are in the Cavaniol group, as is shown in Plate VIII. In the southeastern region nearly all the sandstones are massive, but southwest of Enterprise they are frequently ripple-marked and thin-bedded. Three miles south of South Canadian, sandstones form a prominent escarpment about one hundred feet high. This sandstone is composed of strata that are usually massive, but sometimes flaggy, so that beautiful smooth flags of varying thickness are common. Five or six miles farther to the west, the dark-gray clay shale overlying this bed contains some black carbonaceous fossiliferous limestone nodules. The shales along Salt creek five miles east of Calvin are light gray, very arenaceous, and carry some thin shaly layers of calcareous sandstone that are quite fossiliferous. The sandstone beds, so prominent a feature of this group in the southeast and southern region, gradually grow less prominent to the northward, but as far north as McDermitt they are the prevailing strata. A section across this group in the vicinity of Sapulpa is as follows:

	FEET.
1. Massive and slightly friable sandstones and a little interbedded clays and shales	400
2. Clay shale	100
3. Massive, rather friable sandstones	200
4. Gray clay shale, calcareous in places, and containing two feet of limestone about one hundred and fifty feet from the base of the bed	100

A section across this group west of Oologah shows the following sequence of strata:

	FEET.
1. Sandstones interbedded throughout with arenaceous clay shale	200
2. Fossiliferous shaly limestone	3
3. Clay shales and shaly sandstone	50
4. Hard, massive, gray limestone	25

	FEET.
5. Clay shale	25
6. Arenaceous limestone	5
7. Sandstone	5
8. Clay shale containing calcareous nodules and some fossils	25
9. Gray clay shale, blackened in places by carbonaceous matter often calcareous and occasionally containing thin shaly sandstone strata	300
Total thickness (approximate)	650

Bed 4 of the above section forms the bed-rock of Bird creek about twelve miles from Skiatook along the Skiatook-Pawhuska road. From that point to the eastward it gradually rises until it forms bluffs on either side of the creek and farther eastward forms an east-facing escarpment.

This escarpment was seen about due west of Oologah and two to three miles west of the Osage-Cherokee Nation boundary line. The limestone bed is very massive, gray in color, unevenly textured, rather highly crystalline and contains little ferruginous masses scattered throughout most of the bed.

Origin of the Sediments of the Coal Measures.—Throughout the Coal Measures the thickness of the sediments gradually decreases northward and westward. The most rapid decrease is toward the north, and the lower beds decrease more rapidly than the higher ones. The Lower Coal Measures decrease from a thickness of about seventeen thousand feet in the southern part of the field to a thickness of five hundred to six hundred feet in the northern part. The Upper Coal Measures across the same field decrease from about seventy-five hundred to twelve hundred feet.

The Permian beds, so far as they were studied, show very little, if any, decrease in thickness toward the north. This continuous northward thinning of the beds in the central and northern part of the field is shown in Pl. VIII. The relative proportion in the amount of shales and limestones to sandstones and conglomerates gradually increases westward and especially northward. Because of these conditions the sediments are considered to have come from a land area lying to the southeast.

Permian.

The Permian area studied lies along the western part of the field and extends into it twenty to forty miles. Only about fifteen hundred feet of Permian sediments are included in the area studied. The base of the Permian deposits, as it is defined in the present paper, begins with the first appearance of Permian species, and not with the disappearance of the Coal Measures fauna, for that usually predominates even to the highest beds studied. The strata of the Permian beds consist of massive sandstones, clay shales, conglomerates and limestones. The clay shales are mostly gray and arenaceous, but toward the top they grade through blue to reddish and red shales and marls. The lower two hundred to one thousand feet is composed of alternating clay shale and sandstone beds in about the proportion of one hundred feet of shale to ten of sandstone. These beds are overlain by two hundred and fifty to five hundred feet of sandstones and conglomerates, and these in turn are overlain by bluish and red clay shales and marls which are interstratified with occasional thin sandstones and limestones. Four generalized sections, at widely separated localities, were made across these Permian beds. The first section extends in a northwest direction from Calvin to a point west of Wewoka near the western boundary line of the Seminole Nation. This section will be referred to as the Calvin-Wewoka section. The other three sections, with their localities, are shown in Pl. VIII.

The following table gives the generalized stratigraphy of these four sections:

		FEET.
Calvin-Wewoka Section.....	Red and blue clay shales and marls interstratified with thin sandstone and very rare limestone beds.....	250+
	Conglomerate and sandstone.....	250
	Gray and blue clay shales interstratified with thin sandstone.....	600
	? Massive yellowish weathering friable sandstone	400

Swimmer-Arlington Section.	Red and blue clay shales and marls interstratified with thin sandstone and scarcer limestone beds.....	250+
	Sandstone and conglomerate	500
	Gray arenaceous clay shale beds alternating with sandstone beds in about the proportion of ten of shale to one of sandstone	500
Muscogee-Cushing Section..	Red and blue clay shales and marls interstratified with thin sandstone beds and more rarely thin limestone beds.....	250+
	Alternating blue and gray clay shales and sandstones	200
	Sandstone and a little clay shale.....	500
	Gray clay shales and a few thin sandstone beds.....	100
Adair-Pawhuska Section....	Blue and red clay shales and marls alternating with thin sandstone and a few thin limestone beds.....	500+
	Sandstone and a little clay shale.....	500
	Alternating beds of gray clay shale and thin sandstones.....	200

In general terms, the section farthest to the south, or the Calvin-Wewoka section, shows two thick sandstone groups of beds with an intervening and an overlying clay shale. The other three sections show one principal group of sandstone beds overlain and underlain by clay shales. It may be possible, however, that the lower sandstone group of the Calvin-Wewoka section belongs to the Poteau group, as seems to be the case judging from lithological evidence. If this be true, there are three generalized

groups running through the entire area. The following descriptions of local developments and their general connections will give a better idea of the stratigraphy and lithology.

About five miles northwest of Calvin, along Sandy creek, the strata consist of massive, friable, yellowish sandstones interstratified with gray and yellowish argillaceous compact sand. About a mile farther west, along the Calvin-Wewoka road, there are some sandstone beds exposed which are practically like the above, but are highly fossiliferous and apparently belong either to the Upper Coal Measures, or the Lower Permian. These sandstones are so friable, thick and extensive that the country for fifteen miles or more to the northwest of Calvin is covered by deep loose sand from the disintegration of the rock. Railway cuts three to four miles northwest of Holdenville show the strata at that place to be principally gray arenaceous clays with occasional reddish bands and streaks which carry numerous yellowish, ferruginous, calcareous clay nodules. There is some lenticular interbedded sandstone which is hard and has a clear quartzitic appearance. Similar clay shales and thin interstratified sandstone beds, aggregating a thickness of six hundred feet or more, are the outcropping strata for several miles on either side of Holdenville. It seems probable that this group is the base of the Permian and is the stratigraphic equivalent of about five hundred feet of similar strata outcropping both east and west of McDermitt. Farther to the north it thins quite rapidly or is replaced by sandstone beds until west of Kelleyville and northwest of Skiatook it is but one hundred to two hundred feet thick and contains no red clays. At the top of this group, along the Calvin-Wewoka section, there is a limestone from three to four feet thick. This limestone outcrops about two miles southwest of Wewoka, where it shows a weathered surface of gray and yellowish color, is very friable, and in places is quite arenaceous. About a mile farther west this limestone is overlain by a conglomerate and sandstone bed aggregating two hundred and fifty feet or more in thickness. The larger part of this bed at this locality is conglomerate, composed of rather angular light-colored chert pebbles two to three millimetres in diameter, imbedded in a sand matrix. Occasional well-rounded quartz pebbles, about five millimetres in diameter, also occur in the conglomerate. This conglomerate has the same lithologic characteristics of the conglomerate beds that extend from northern to central Texas through

the Cisco division of the Coal Measures of Texas.[1] The outcrop of this conglomerate and sandstone bed forms a belt ten miles wide that extends nearly north and south through the centre of the Seminole Nation. Farther northward the conglomerate gradually disappears and the beds thicken by addition of other sandstone beds until it is apparently five hundred feet thick and outcrops in a belt about twenty miles wide. This belt lies twelve miles east of Arlington, two miles west of Kelleyville, and about eight or ten miles east of Pawhuska.

The sandstones of this belt are so friable that the country is covered by loose sand derived from the disintegrated rock. About fourteen miles east of Arlington the group contains a bed of light-gray sandy clay shale, seventy-five or one hundred feet thick, which contains some limonite nodules and one thin stratum of rich hematite. There are also two strata of limestone, each one or two feet thick, which occur near the base and top of the shales respectively.

Proceeding upward and westward across this sandstone and conglomerate group of beds from about a mile west of Kelleyville to about eight miles west of that place, the strata are found to be mainly sandstones, which are massive, rather ferruginous, friable and weather into rough irregular shapes. The rapid disintegration of the rock covers the ground with deep loose sand. About nine miles west of Kelleyville the sandstone is slightly shaly in places and some red sandy clays are interstratified with the sandstone beds. The dip of these beds is about fifty feet per mile to the westward, or a little north of westward. The thin interbedded shales and clays and alternating harder sandstone beds allow only very slight escarpments to be formed. On top of these sandstones there is about one hundred feet of gray sandy clay shale and some interstratified shaly sandstone. Over the outcrop of this shale there is not much loose sand and the bed is marked by little prairies. The dip of the strata here is about twenty to twenty-five feet per mile to the westward. Ten to eleven miles west of Kelleyville the rocks are massive cross-bedded sandstones; in these the bedding planes are curved surfaces separating their lenticular and wedge-shaped layers. It is interstratified with a little bluish argillaceous sand, red clays and gray argillaceous sandy shale. For the next five or six miles to the westward the strata lie practically horizontal, then farther west to the top of the sandstone group,

[1] *Geol. Surv. Texas*, Fourth An. Rep., 1892, pp. 372, 445; *Geol. Surv. Texas*, Second An. Rep., 1890, pp. 362, 495, 509, and Pl. xvi.

which is about two miles west of Polecat creek, sixteen miles east of Cushing, the strata apparently dip about twenty-five feet per mile. The top of this group outcrops along the bed of Bird creek, one mile west of Pawhuska. On either side of the creek, beds of gray and bluish clay shales and some thin sandstone beds overlie the main sandstone group, so that it does not form the chief outcrops until a point about ten miles southeast of Pawhuska is reached.

From Pawhuska the rocks of this group outcrop southeastward along the Skiatook-Pawhuska road for about fifteen miles. The principal variation across this Adair-Pawhuska section is a slight increase of argillaceous strata. A three-foot bed of brownish weathering arenaceous limestone occurs about one and a half miles east of the road crossing Birch creek. From Birch creek westward the dip of the strata appears to be twenty-five to thirty feet per mile to the westward, while for five or six miles to the east the strata are almost horizontal.

The next higher group of Permian beds consists of bluish and red clay shales and marls, interstratified at rather wide intervals with thin cross-bedded sandstones and occasional thin limestones. The following local developments will give the usual characteristics. The lower part of this group, as seen eight to nine miles west-southwest from Wewoka, consists of sandy clay shales, bluish and reddish colored, and massive sandstones that have edges and parts of the rock broken into thin shaly wedge-shaped, cross-bedded strata. The sandstone is either light grayish or reddish-colored. The gray sandstone is coarse textured. Farther westward and higher geologically the sandstones decrease in quantity and most of the strata are red clay shales.

Two and a half miles southeast of Econtuska there is a little white, nodular, arenaceous limestone interstratified with yellowish marls. The strata at Bellmont and between that place and Arlington are mainly red arenaceous, calcareous clays interstratified with occasional red sandstones which are usually rather massive, but often broken into shaly and flaggy parts by cross-bedding planes. Some of the sandstone has a light gray-color. There are also rare beds of arenaceous and even quite pure fossiliferous limestone which varies in color from white and gray to red and almost invariably weathers to rough nodular fragments. One of these beds outcrops one mile west of Arlington. Five or six miles east of Arlington there is a one to three-foot bed of hard crystalline red limestone

which is overlain by a thin clay bed, and this in turn by sandstone conglomerate similar to that west of Wewoka.

The limestone that outcrops one mile west of Arlington is probably the same as the one that occurs sixteen miles east of Cushing and two miles west of Pawhuska. Dr. J. P. Smith called the limestone bed that outcrops from two to three miles west of Pawhuska, the Pawhuska limestone.[1]

The limestone bed that outcrops about sixteen miles east of Cushing is from four to six feet thick, gray, bedded in rough, thin layers, and contains *Fusulina* and crinoids. The strata here lie almost horizontal, and the same bed outcrops ten miles east of Cushing along the Kelleyville-Cushing road. About five miles east of Cushing higher beds of massive friable cross-bedded sandstone, red clay, and arenaceous limestone outcrop. Some of the limestone is quite pure, but usually it occurs in nodular form in beds one-half to one foot thick. In the vicinity of Cushing clay shales and marls are the principal strata. Six miles north-northwest from Cushing along the south or east bank of the Cimarron river there is a bluff about fifty feet high showing massive and shaly sandstones of light gray or yellowish and reddish color, sometimes cross-bedded. A little rough concretionary limestone occurs at the top of the bed. The twin peaks from ten to eleven miles north of Cushing are composed of red clays capped by concretionary limestone. Some of the limestone contains chert. The Pawhuska limestone outcrops about twelve miles north of Cushing along branches of Salt creek. The bed at this locality is about five feet thick, gray in color, hard, rough surfaced, unevenly textured and rich in two species of *Fusulina*.

The following section was compiled from outcrops of strata found five to ten miles south of Pawnee.

	FEET.
1. Red clays	at top.
2. Limestone	1½
3. Red, bluish and gray clays	150
4. Limestone (Pawnee limestone)[2]	2
5. Principally gray clay shales	100
6. Pawhuska limestone	5

[1] *Jour. Geol.*, Vol. ii, p. 199.

[2] Stratum 4 appears to be the same as the bed of limestone outcropping on the east side of the courthouse grounds at Pawnee, and for convenience it will be called the Pawnee limestone.

The Pawnee limestone outcrop on the east side of the courthouse grounds at Pawnee consists of three to four feet of hard evenly textured, tough, bluish gray limestone underlain by five to six feet of yellowish blue marls. Both the limestone and marls are rich in fossils. The Pawhuska limestone bed which outcrops in the bed of a creek half a mile northeast of Pawnee at an elevation of about one hundred feet below the Pawnee limestone, is, at this place, about five feet thick; the lower three feet is hard and massive, while the upper part of the bed is friable. *Fusulinæ* are very abundant in this bed.

Four miles south of Ralston in the banks of Coal creek there is a three to five-inch bed of coal which appears to be below the Pawnee limestone. The following section was compiled from exposures of an escarpment facing the Arkansas river valley at a point about two miles southeast of Ralston.

	FEET.
1. Light gray and yellowish weathering sandstone	15
2. Gray clay shale	4
3. Nodular gray limestone (Pawnee limestone?)	3
4. Red clays and light gray shaly sandstones	100
5. Pawhuska (?) limestone	5

The Pawhuska limestone outcrops along the Gray Horse-Pawhuska road at every creek crossing for seven to eight miles from Gray Horse, and also about five miles southwest of Pawhuska. At the latter place it is about ten feet thick, unevenly textured, gray in color, and underlain by yellowish and bluish clays. A section of the strata in the vicinity of Pawhuska is about as follows:

	FEET.
1. Blue and red clays	at top.
2. Pawhuska limestone	10
3. Clay shale	50
4. Sandstone	50
5. Clay shale	150
6. Sandstones	at base.

This limestone outcrop forms a little escarpment facing east and running north about two miles west of Pawhuska, while the first sandstone bed below the limestone cap the buttes and escarpments around the village.

General Classification of Rocks of the Indian Territory.[1]

System.	Series.	Group.	Correlations.	Beds.	Maximum Thickness in Feet.
Carboniferous	Permian.		Albany division, Texas. Neosho and Chase formations, Kansas.	Shales, sandstones, conglomerates and limestones.	1,500
	Coal Measures	Poteau.	Wabaunsee and Cottonwood formations, Kansas. Cisco division, Texas.	Massive and shaly sandstones and shales.	2,000
		Cavaniol.	Missouri formation, Kansas.	Shales, sandstones and coals	5,500
		Lower Coal M.	Strawn, Milsap and Canyon divisions, Texas	Shales, sandstones.	17,000
	Lower Carboniferous.	Boston.	St. Louis.	Limestones, shales and sandstones.	200
		Osage.	Osage.	Batesville sandstone.	25
				Fayetteville shale.	50
				Boone chert and limestone.	500
		Kinderhook.		Eureka shale.	50
				Wanting.	
Devonian.	Devonian.			Wanting.	
Silurian.	Upper Silurian		Niagara, New York. St. Clair Marble, Arkansas.	Marble and saccharoidal sandstone.	75+
	Lower Silurian			Saccharoidal sandstone, chert and dolomitic sandstones and limestones.	200+

[1] Since this paper was put in type Mr. Stuart Weller has definitely correlated the Batesville sandstone of these tables with the Aux Vases sandstone of Illinois. His results show that the hitherto tentative correlations of these Arkansas and Indian Territory rocks require more careful paleontologic study.—*Trans N. Y. Acad. Sci.*, xvi, 251–282.

PART II.

PALEONTOLOGY.

The fossils collected from various localities over the field are listed in locality groups, and arranged in their stratigraphic order. All the species listed here and the originals figured are deposited in the geological museum of Stanford University.

LOWER CARBONIFEROUS.

Upper Boone Limestone (Burlington–Keokuk).—Collections of fossils from the upper Boone limestone were made at three different localities. At the north side of West monntain, three miles southeast of Westville, the following fauna was found :

1. *Productus scabriculus* ? Martin.
2. *Productus cherokeeensis* n. sp. Drake.
3. *Productus* (*Marginifera*) *adairensis* n. sp. Drake.
4. *Productus ovatus* Hall.
5. *Athyris* (*Seminula*) *subquadrata* Hall.
6. *Rhynchonella grosvenori* White.
7. *Spirifer keokuk* Hall.
8. *Eumetria vera* Hall.
9. *Rhynchonella mutata*? White.
10. *Discina* sp.?
11. *Archimedes* sp.?

Seven miles east of Adair the upper Boone limestone contains the following fauna :

1. *Productus* (*Marginifera*) *adairensis* n. sp. Drake.
2. *Productus ovatus* Hall.
3. *Productus longispinus* ? Sowerby.
4. *Productus* sp.?
5. *Derbya kaskaskiensis* McChesney.
6. *Spirifer keokuk* Hall.
7. *Athyris* (*Seminula*) *subquadrata* Hall.
8. *Orthothetes crenistria* Phillips.
9. *Myalina* sp.?
10. *Archimedes* sp.?

The following fossils were collected from outcrops of the upper Boone limestone found along Ballard's creek one mile west of Echo:

1. *Orthothetes crenistria* Phillips.
2. *Productus cestriensis* Worthen.
3. *Orthis swallovi* Hall.
4. *Eumetria vera* Hall.
5. *Athyris* sp.?
6. *Archimedes* sp.?
7. *Phillipsia* sp.?

Fayetteville Shale (Warsaw).—No fossils were collected from the shale itself, but the limestone bed that occurs near the centre of the shale bed is very fossiliferous in places. One and a half miles south of Vinita *Productus cestriensis* Worthen is a very common fossil in this limestone. East of Chouteau on either side of Grand River valley, opposite Ned Adair's ferry, the following fauna was collected from this limestone:

1. *Productus ovatus* Hall.
2. *Productus cherokeeensis* n. sp. Drake.
3. *Productus alternatus* N. and P.
4. *Productus* sp.?
5. *Productella* sp.?
6. *Athyris* (*Seminula*) *subquadrata* Hall.
7. *Athyris* sp.?
8. *Spirifer keokuk* Hall.
9. *Spirifer trigonalis* Martin.
10. *Rhynchonella* (*Camarophoria*) *cooperensis* Shumard.
11. *Chonetes planumbona* M. and W.
12. *Pentremites godoni* de France.
13. *Pleurotomaria taggerti* Meek.
14. *Pleurotomaria* sp.?
15. *Platyceras* sp.?
16. *Edmondia burlingtonensis* White and Whitfield.
17. *Edmondia ellipsis* White and Whitfield.

Boston Group (St. Louis–Chester).—A very good representative fauna of this group was collected at four different localities. Most of the fossils came from the Archimedes and Pentremital horizons. The following fauna was found in this group east of Grand river,

opposite Wagoner, about one and a half miles northeast of the mouth of Fourteen Mile creek.

1. *Productus ovatus* Hall.
2. *Productus cestriensis* Worthen.
3. *Productella* sp.?
4. *Spirifer* sp.?
5. *Terebratula bovidens* Morton.
6. *Athyris* (*Seminula*) *subquadrata* Hall.
7. *Athyris* sp.?
8. *Camarophoria worthent* Hall.
9. *Eumetria verneuilana* Hall.
10. *Eumetria vera* Hall.
11. *Aviculopecten simplex* ? Dawson.
12. *Posidonomya fracta*? Meek.
13. *Edmondia* sp.?
14. *Pentremites godoni* de France.
15. *Archimedes communis* Ulrich.
16. *Archimedes swallovana* Hall.
17. *Archimedes terebreformis* Ulrich.
18. *Archimedes* sp.?
19. *Zaphrentis spinulifera* Hall.
20. *Phillipsia* sp.?

The following fauna was collected from this group five miles east of Adair.

1. *Productus* (*Marginifera*) *adairensis* n. sp. Drake.
2. *Productus cherokeeensis* n. sp. Drake.
3. *Productus cestriensis*? Worthen.
4. *Productus pertenuis*? Meek.
5. *Productella* sp.?
6. *Chonetes loganensis*? Hall.
7. *Orthis dubia* Hall.
8. *Orthothetes crenistria* Phillips.
9. *Spiriferina kentuckensis* Shumard.
10. *Rhynchonella grosvenori* White.
11. *Eumetria verneuilana* Hall.
12. *Spirifer keokuk* Hall.
13. *Athyris* (*Seminula*) *subquadrata* Hall.
14. *Phillipsia scitula* M. and W.

Seven or eight miles southeast of Big Cabin the following collection was made:

1. *Productus cherokeeensis* n. sp. Drake.
2. *Productella* sp.?
3. *Athyris* (*Seminula*) *subquadrata* Hall.
4. *Spiriferina kentuckensis* Shumard.
5. *Rhynchonella grosvenori* White.
6. *Eumetria vera* Hall.
7. *Chonetes* sp.?
8. *Archimedes* sp.?
9. *Zaphrentis* sp.

The Boston group contains the following fauna one and a half miles south of Vinita:

1. *Productus cherokeeensis* n. sp. Drake.
2. *Productus cora*? d'Orbigny.
3. *Athyris* (*Seminula*) *subquadrata* Hall.
4. *Chonetes planumbona*? M. and W.
5. *Spiriferina kentuckensis* Shumard.
6. *Spirifer keokuk* Hall.
7. *Straparollus lens*? Hall.
8. *Zaphrentis lanceolata*? Worthen.
9. *Archimedes proutanus* M. and W.
10. *Michelinia eugeneæ* White.
11. *Orthoceras* sp.?
12. *Bellerophon* sp.?
13. *Pleurotomaria* sp.?

Coal Measures.

LOWER COAL MEASURES.

The Lower Coal Measures are very poor in fossils, and collections of any special value were made at only three different localities:

Along the limestone bed and ridge two and a half miles south of Ponola and Wilburton.

1. *Productus longispinus*? Sowerby.
2. *Productus cora*? d'Orbigny.
3. *Derbya crassa*? M. and W.
4. *Rhynchonella illinoisensis* Worthen.

5. *Athyris* sp.?
6. *Spiriferina*? *kentuckensis* Shumard.
7. *Retzia*?
8. *Spirifer* sp.?
9. *Spirifer rockymontanus* Marcou.
10. *Septopora*?
11. *Playtyceras* sp.?

One mile south of Muscogee the following fossils were found in shaly and friable limestones and arenaceous clay shales:

1. *Productus pertenuis*? Meek.
2. *Productus splendens* N. and H.
3. *Productus longispinus* Sowerby.
4. *Spirifer lineatus* Martin.
5. *Spirifer rockymontanus* Marcou.
6. *Spirifer* sp.?
7. *Derbya crassa* M. and P.
8. *Discina convexa* Shumard.
9. *Athyris* (*Seminula*) *subtilita* Hall.
10. *Septopora biserialis* Swallow.
11. *Zaphrentis* sp.?

Four miles north of Vinita, where the M. K. & T. railway crosses a brook, the following fauna was collected from some black shale:

1. *Productus pertenuis*? Meek.
2. *Spirifer cameratus* Morton.
3. *Athyris* (*Seminula*) *subtilita* Hall.
4. *Derbya crassa* Meek and Hayden.
5. *Chonetes* sp.?
6. *Bellerophon* sp.?

UPPER COAL MEASURES.

Cavaniol Group.—This group is represented in the collection of fossils from five different localities as follows:

The following fossils were found in a ferruginous sandstone one hundred and fifty feet above the Grady coal and four miles northwest of Hackett, Ark.

1. *Derbya crassa* M. and H.
2. *Nuculana bellistriata* Stevens.
3. *Bellerophon carbonarius* Cox.
4. *Aviculopecten occidentalis* Shumard.

One and a half miles west of Starvilla along a little branch some shaly argillaceous limestone contains great numbers of *Productus pertenuis*? Meek, and *Discina nitida* Phillips occurs rarely. In some ferruginous sandstone, six miles southwest of Salisaw on the east side of Big Salisaw creek, the following fauna was collected:

1. *Productus cora* d'Orbigny.
2. *Terebratula bovidens* Morton.
3. *Athyris* (*Seminula*) *subtilita* Hall.
4. *Spirifer rockymontanus* Marcou.
5. *Retzia* (*Hustedia*) *mormoni* Marcou.
6. *Derbya crassa* M. and H.
7. *Aviculopecten occidentalis* Shumard.

The following fauna was collected from the Oologah limestone in the western part of the town of that name:

1. *Productus semireticulatus* Martin.
2. *Athyris* (*Seminula*) *subtilita* Hall.
3. *Chonetes* sp.?
4. *Syringopora* sp.?

The following fossils were found in the limestone bed that outcrops along Verdigris river a quarter of a mile below the McClellan ford, which is about four miles east of Talala. This limestone belongs about two hundred feet below the Oologah limestone:

1. *Productus punctatus* Martin.
2. *Productus semireticulatus* Martin.
3. *Productus* (*Marginifera*) *splendens* N. and P.
4. *Productus pertenuis*? Meek.
5. *Spirifer cameratus* Morton.
6. *Spirifer lineatus* Martin.
7. *Spiriferina kentuckensis* Shumard.
8. *Athyris* (*Seminula*) *subtilita* Hall.
9. *Chonetes mesoloba* N. and P.
10. *Chonetes* sp.?
11. *Fusulina cylindrica* Fischer.

Poteau Group Fauna.—Collections of fossils were made at four different localities in this group. The shales immediately overlying the Mayberry coal bed at the coal mines, four miles northwest of Poteau, contain the following fauna:

1. *Discina nitida* Phillips.
2. *Aviculopecten rectilaterarius* Cox.
3. *Aviculopecten dubertianus* Dawson.
4. *Nuculana bellistriata* Stevens.
5. *Nucula ventricosa* Hall.
6. *Bellerophon carbonarius* Cox.
7. *Gastrioceras globulosum*? Meek and Worthen.

Six miles southwest of South Canadian some limestone nodules included in a clay shale bed contain the following fossils:

1. *Nucula ventricosa* Hall.
2. *Pleurotomaria sphærulata* Conrad.
3. *Bellerophon crassus* Meek and Worthen.

Five or six miles northwest of Calvin, the following fauna occurs in friable sandstones:

1. *Productus semireticulatus* Martin.
2. *Productus pertenuis*? Meek.
3. *Strophalosia*? *spondyliformis* White and St. John.
4. *Schizodus wheeleri* Swallow.
5. *Nuculana bellistriata* Stevens.
6. *Murchisonia* sp.?
7. *Pinna peracuta* Shumard.
8. *Aviculopecten catactus*? Meek.
9. *Gastrioceras globulosum* Meek and Worthen.

Ten miles south of Okmulgee, about one hundred and fifty feet above the base of the Poteau group, the following fossils were found in sandstone:

1. *Aviculopecten occidentalis* Shumard.
2. *Solenopsis solenoides* Geinitz.
3. *Pleurophorus angulatus* Meek and Worthen.

The following fossils were collected west of Oologah, about two miles west of the Cherokee-Osage Nation boundary line:

1. *Productus splendens* N. and P.
2. *Spirifer cameratus* Morton.
3. *Spirifer lineatus* Martin.
4. *Athyris* (*Seminula*) *subtilita* Hall.
5. *Spiriferena kentuckensis* Shumard.

6. *Meekella striatocostata* Cox.
7. *Temnocheilus forbesianus* McChesney.
8. *Chonetes* sp. ?

Near the top of the group, at a place about ten miles northwest of Skiatook, the following fauna was found in sandstone strata:

1. *Chonetes verneuilana* N. and P.
2. *Chonetes laevis* Keyes.
3. *Productus* sp.?
4. *Sanguinolites* sp.?

Permian Fauna.

Good collections of fossils were made at three different places from beds that are classed as the lowest Permian. The first two lists given below afford the evidence that has been used to draw the line between the Permian and the Coal Measures. These two collections of fossils come from widely separated localities and apparently from the same stratigraphic position.

Five miles east of McDermitt along the McDermitt-Chelsea road the following fauna was found in beds of sandstone.

1. *Productus semireticulatus* Martin.
2. *Productus nebrascensis* Owen.
3. *Productus auriculatus* Swallow.
4. *Orthis* sp.?
5. *Derbya crassa* Meek and Hayden.
6. *Nuculana bellistriata* Stevens.
7. *Pinna peracuta* Shumard.
8. *Aviculopecten occidentalis* Shumard.
9. *Aviculopecten* sp.?
10. *Myalina swallovi* McChesney.
11. *Edmondia aspenwallensis* Meek.
12. *Edmondia reflexa* Meek.
13. *Schizodus wheeleri* Swallow.
14. *Schizodus insignis* nov. sp. Drake.
15. *Macrodon obsoletus* Meek.
16. *Macrodon carbonarius* Cox.
17. *Bakevellia parva*? M. and H.
18. *Murchisonia marcouiana.*
19. *Gervilia ohioensis* Herrick.

20. *Pleurophorus angulatus* Meek and Worthen.
21. *Pleurophorus* sp.?
22. *Pleurotomaria* sp.?
23. *Pseudomonotis hawni* Meek and Hayden.

Four miles west of Sapulpa and about one-half of a mile north of the Sapulpa-Kelleyville road the following fauna was collected.

1. *Productus cora*? d'Orbigny.
2. *Derbya crassa* Meek and Hayden.
3. *Chonetes verneuilana* Norwood and Pratten.
4. *Chonetes lævis* Keyes.
5. *Myalina swallovi* McChesney.
6. *Nucula bellistriata* Stevens.
7. *Edmondia nebrascensis* Geinitz.
8. *Dentalium meekianum* Geinitz.
9. *Solenopsis solenoides* Geinitz.
10. *Yoldia subscitula* Meek and Hayden.
11. *Schizodus wheeleri* Swallow.
12. *Pseudomonotis hawni*? Meek and Hayden.
13. *Pleurophorus angulatus* Meek and Worthen.
14. *Pleurophorus* sp.?
15. *Pleurophorus* sp.?
16. *Pleurotomaria sphærulata*? Conrad.
17. *Murchisoma* sp.?
18. *Bellerophon carbonarius* Cox.

Three or four miles west of McDermitt, and about one mile west and northwest of the Pigler place, there are some highly fossiliferous sandstones. These beds are three hundred or four hundred feet above the base of the beds containing the fossils of the above two lists. Fossils were collected from two different sandstone beds in these higher horizons four miles west of McDermitt. The lower sandstone bed contains the following fossils:

1. *Productus nebrascensis* Owen.
2. *Productus auriculatus* Swallow.
3. *Pinna peracuta*? Shumard.
4. *Myalina swallovi* McChesney.
5. *Aviculopecten occidentalis* Shumard.
6. *Pleurotomaria* sp.?

The upper fossiliferous sandstone bed lies about fifty to seventy-five feet higher and contains the following fauna:

1. *Productus semireticulatus* Martin.
2. *Productus nebrascensis* Owen.
3. *Productus pertenuis* Meek.
4. *Productus auriculatus* Swallow.
5. *Derbya crassa* Meek and Hayden.
6. *Athyris* sp.?
7. *Orthis resupinoides*? Cox.
8. *Edmondia gibbosa* Swallow.
9. *Pinna peracuta* Shumard.
10. *Myalina swallovi* McChesney.
11. *Myalina recurvirostris*? Meek and Worthen.
12. *Myalina subquadrata* Shumard.
13. *Schizodus wheeleri* Swallow.
14. *Schizodus curtus*? Meek and Worthen.
15. *Bakevellia parva*? Meek and Hayden.
16. *Dentalium meekianum* Geinitz.
17. *Monopteria gibbosa* Meek and Worthen.
18. *Aviculopecten occidentalis* Shumard.
19. *Nucula bellistriata* Stevens.
20. *Pseudomonotis hawni* Meek and Hayden.
21. *Gervillia ohioensis* Herrick.
22. *Loxonema cerithiforme*? Meek and Worthen.
23. *Avicula* sp.?
24. *Avicula* sp.
25. *Pleurophorus* sp.
26. *Sanguinolites*?

The Seminole sandstone and conglomerate beds that run northward through the Territory are, as a rule, barren of fossils, and no collections of importance were made in them.

Pawnee and Pawhuska Beds.—Collections of fossils from these beds were made at ten different localities. These fossils were collected from strata that apparently extend from the base of the Pawhuska limestone to a horizon three hundred or four hundred feet above that limestone. The first five lists of fossils come from strata that appear to belong to the Pawhuska limestone. One to four miles southwest of Arlington the following fossils were found in a limestone bed.

1. *Productus* (*Marginifera*) *splendens* Norwood and Pratten.
2. *Spirifer cameratus* Morton.
3. *Choneies verneuilana* Norwood and Pratten.
4. *Allorisma subcuneatum* Meek and Hayden.
5. *Pinna peracuta*? Shumard.

The following fauna was found in what appears to be the Pawhuska limestone, along branches of Salt Creek twelve miles north of Cushing.

1. *Spirifer cameratus* Morton.
2. *Spirifer planoconvexus* Shumard.
3. *Athyris* sp.?
4. *Schizodus wheeleri* Swallow.
5. *Zaphrentis* sp.
6. *Fusulina cylindrica* Fischer.
7. *Fusulina gracilis*? Meek.

About ten to fifteen feet above this limestone, at a place eleven miles south of Pawnee, the following fossils were collected:

1. *Productus cora* d'Orbigny.
2. *Chonetes granulifera* Owen.
3. *Spirifer cameratus* Morton.
4. *Athyris sultilita* Hall.
5. *Myalina subquadrata* Shumard.
6. *Bellerophon percarinatus* Conrad.

The following fossils were found in the limestone bed outcropping in the bed of the creek at the road crossing one-half mile northeast of Pawnee courthouse.

1. *Productus* (*Marginifera*) *splendens* Norwood and Pratten.
2. *Chonetes granulifera* Owen.
3. *Chonetes lævis* Keyes.
4. *Rhynchonella* (*Pugnax*) *uta* Marcou.
5. *Spirifer cameratus* Morton.
6. *Athyris* (*Seminula*) *subtilita* Hall.
7. *Fusulina cylindrica* Fischer.

The following fauna was found in the Pawhuska limestone at a place about four and one-half miles southwest of Pawhuska.

1. *Productus semireticulatus* Martin.

2. *Productus cora* d'Orbigny.
3. *Athyris* (*Seminula*) *subtilita* Hall.
4. *Spirifer cameratus* Morton.
5. *Spirifer planoconvexus* Shumard.
6. *Chonetes* sp. ?
7. *Lophophyllum proliferum* Hall.
8. *Pleurotomaria illinoisensis* Worthen.

The following fossils were collected from a friable limestone bed that occurs about one hundred and fifty feet above the Pawhuska limestone, at a place five miles east of Cushing.

1. *Productus pertenuis* Meek.
2. *Derbya crassa* Meek and Hayden.
3. *Chonetes granulifera* Owen.
4. *Spirifer cameratus* Morton.
5. *Aviculopecten occidentalis* Shumard.
6. *Myalina* sp. ?
7. *Rhombopora lepidodendroides* ? Meek.

Ten miles north of Cushing the following fauna was collected from some limestone strata capping Twin hills.

1. *Spirifer cameratus* Morton.
2. *Productus* (*Marginifera*) *splendens* N. and P.
3. *Chonetes granulifera* Owen.
4. *Athyris* (*Seminula*) *subtilita* Hall.
5. *Syntrielasma hemiplicatum* Hall.
6. *Fusulina cylindrica* Fischer.

On the east side of the courthouse grounds at Pawnee there is an outcrop of four feet of limestone, and four feet of fossiliferous calcareous gray clays. Fossils collected from this bed are as follows:

1. *Productus semireticulatus* Martin.
2. *Productus cora* d'Orbigny.
3. *Productus pertenuis* Meek.
4. *Productus nebrascensis* Owen.
5. *Productus* (*Marginifera*) *splendens* N. and P.
6. *Spirifer cameratus* Morton.
7. *Spirifer planoconvexus* Shumard.
8. *Derbya crassa* Meek and Hayden.
9. *Meekella striatocostata* Cox..

10. *Rhynchonella* (*Pugnax*) *uta* Marcou.
11. *Chonetes granulifera* Owen.
12. *Orthis pecosi* Marcou.
13. *Athyris* (*Seminula*) *subtilita* Hall.
14. *Aviculopecten occidentalis* Shumard.
15. *Euomphalus rugosus* Hall.
16. *Fusulina cylindrica* Fischer.
17. *Rhombopora lepidodendroides* Meek.
18. *Zeacrinus* sp.?

The following list of fossils shows the fauna that was found about two miles southeast of Ralston, in a bed of limestone, and marls that appear to be the same as that in Pawnee.

1. *Productus semireticulatus* Martin.
2. *Productus nebrascensis* Owen.
3. *Productus* (*Marginifera*) *splendens*? N. and P.
4. *Rhynchonella* (*Pugnax*) *uta* Marcou.
5. *Derbya crassa* Meek and Hayden.
6. *Spirifer cameratus* Morton.
7. *Spirifer* (*Ambocœlia*) *planoconvexus* Shumard.
8. *Athyris* (*Seminula*) *subtilita* Hall.
9. *Spiriferina kentuckensis* Shumard.
10. *Meekella striatocostata* Cox.
11. *Chonetes granulifera* Owen.
12. *Chonetes lævis* Keyes.
13. *Retzia* (*Hustedia*) *mormoni* Marcou.
14. *Orthis pecosi* Marcou.
15. *Aviculopecten occidentalis* Shumard.
16. *Aviculopecten* sp.?
17. *Avicula speluncaria* Geinitz (not Schlotheim).
18. *Myalina subquadrata* Shumard.
19. *Myalina perattenuata* Meek and Hayden.
20. *Astarte* sp.?
21. *Bellerophon* sp.?
22. *Lophophylium proliferum* Hall.
23. *Phillipsia scitula*? Meek and Worthen.

The following fauna was collected from sandstone beds that outcrop six to seven miles southwest of Pawhuska along the Paw-

huska-Gray Horse road. These sandstone beds are probably one hundred and fifty feet above the Pawhuska limestone.

1. *Pinna peracuta* Shumard.
2. *Schizodus wheeleri* Swallow.
3. *Schizodus rossicus* Verneuil.
4. *Nucula bellistriata* Stevens.
5. *Aviculopecten* sp.?
6. *Pleurophorus angulatus* Meek and Worthen.
7. *Pleurophorus* sp.?
8. *Myalina swallovi* McChesney.
9. *Yoldia subscitula* Meek and Hayden.
10. *Pleurotomaria perhumerosa* Meek.
11. *Bellerophon* sp.?

Descriptions of Species.

Productus (*Marginifera*) *adairensis* sp. nov. Drake. Pl. IX, Figs. 1–3.

Shell small, the largest specimen found being three-quarters of an inch in height, and seventeen-twentieths of an inch in greatest breadth, at hinge line. Beak highly arched, and projecting one-third of the entire height of the shell above the hinge line. Ears slightly extended. Surface ornamented with very fine ribs, and occasional small spines, and in the region of the beak, with a slight reticulation. The ventral valve has a distinct medial sinus, which begins near the beak. The outside of the shell resembles somewhat *Productus multistriatus* Meek, of the Upper Carboniferous, but has the ribs even finer, and the beak somewhat more slender than that species. The inside of the shell shows the characters

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Plate IX.

PAGE.

Figs. 1, 2 and 3.—*Productus adairensis* nov. sp. Drake. Fig. 2, from Boone limestone, seven miles east of Adair. Figs. 1 and 3, from Boston group, five miles southeast of Adair 403

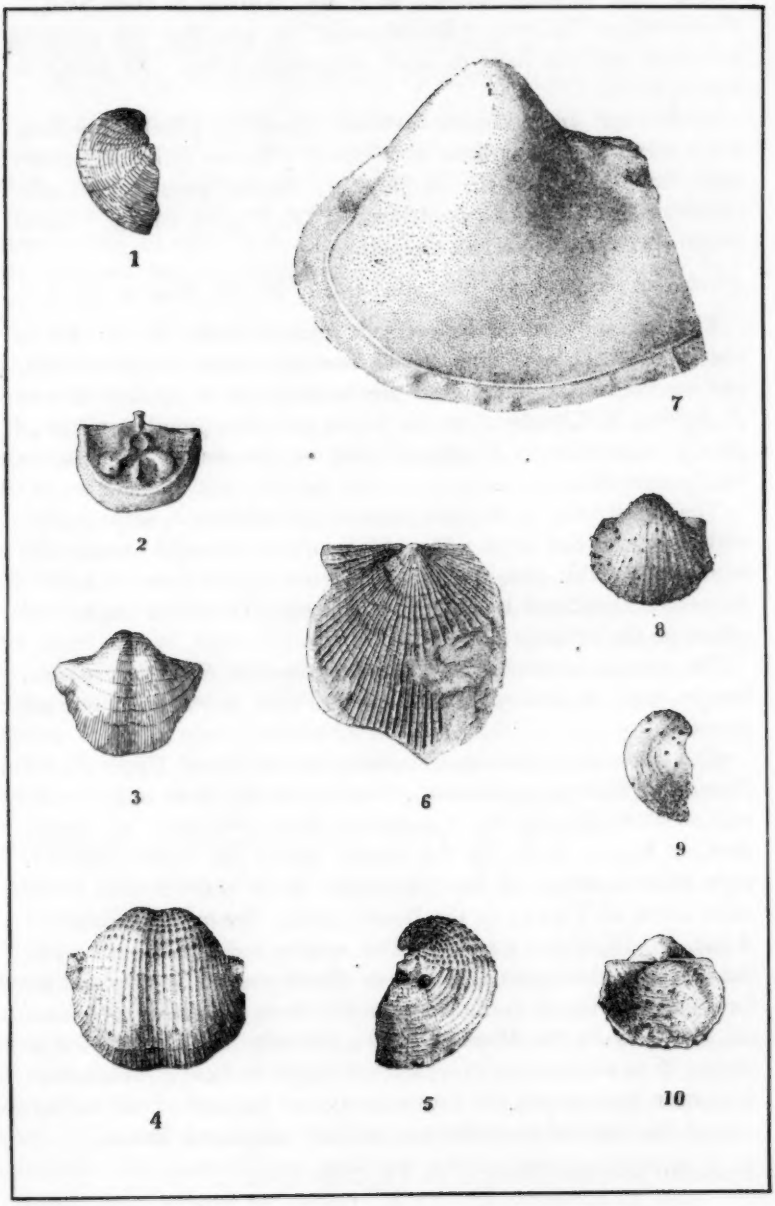
Figs. 4 and 5.—*Productus cherokeeensis* nov. sp. Drake. Boston group, five miles southeast of Adair 403

Fig. 6.—*Aviculopecten rectilaterarius* Cox. Upper Coal Measures, Poteau group, four miles northwest of Poteau 403

Fig. 7.—*Schizodus insignis* nov. sp. Drake. Permian, five miles east of McDermitt 403

Figs. 8, 9 and 10.—*Productus pertenuis* Meek. Lower Carboniferous, St. Louis-Chester, five miles southeast of Adair 403

Plate IX.



assigned by Waagen to his genus Marginifera, although Hall and Clarke have recently shown, in "Nat. History of New York," *Palæontology*, Vol. viii, "Brachiopoda," p. 331, that the genus is not valid, and can have at most subgeneric value. As such it is here retained.

Occurrence and Horizon.—Boone limestone (Burlington-Keokuk), three miles southeast of Westville; Boone limestone, seven miles east of Adair, Pl. IX, Fig. 2; Boston group (St. Louis-Chester), five miles east of Adair, Pl. IX, Figs. 1 and 3. About fifteen specimens collected, altogether.

Productus cherokeeensis nov. sp. Drake. Pl. IX, Figs. 4 and 5.

This species resembles closely *P. semireticulatus* Martin, but is always smaller, more compressed laterally, more highly arched, and has the mesial sinus more pronounced. It is nearest akin to *P. inflatus* McChesney, but the umbo is not so prominent, nor so greatly incurved as in *P. inflatus;* also the ribs seem a little coarser on *P. cherokeeensis.*

The dorsal valve is strongly concave, the ventral is very convex, with strong medial sinus. The surface of both valves is ornamented with distinct ribs, often dichotomous; the region near the beak is distinctly reticulated by the growth lines. There are occasional spines on the surface.

The ears are somewhat more extended than on *P. semireticulatus*, but the total proportional width of the shell is less than on that species.

Occurrence and Horizon.—Rather common in the Upper Boone limestone (Burlington-Keokuk), West mountain, three miles southeast of Westville; in the Fayetteville shale (Warsaw), on Grand river, at Adair's ferry; in the Boston group (St. Louis-Chester), eight miles southeast of Big Cabin, and in the same horizon a half miles south of Vinita; in the Boston group, five miles southeast of Adair, Pl. IX, Figs. 4 and 5. The species is confined entirely to the Lower Carboniferous in Indian Territory, and a very similar form has been found in the Fayetteville shale (Warsaw) of Arkansas, and also in the Marshall shale, probably St. Louis, of that State. It is worth while to separate this species from *P. semireticulatus* from its stratigraphic importance, and because of the unlikeness of the two and the difference of their associated faunas.

Productus pertenuis Meek. Pl. IX, Figs. 8–10.

Productus pertenuis Meek. *Final Report U. S. Geol. Survey Nebraska*, p. 164, Pl. I, Fig. 14, Pl. VIII, Fig. 9.

Productus cancrini Geinitz. *Carbon und Dyas in Nebraska*, p. 54, Pl. IV, Fig. 6 (not Murchison, Verneuil and Keyserling).

The specimens referred to *Productus pertenuis* are rather larger than those figured by Meek, and have somewhat stronger radial ribs. But the thinness of the valves, the great convexity of the ventral valve, the lack of a medial sinus, and the disposition of the small spines all agree with the figures and descriptions of Meek's *P. pertenuis*, and the form referred by Geinitz to *P. cancrini* M. V. K.

Adults of the shell average about three-fifths of an inch wide and the same in height; convexity of the valve for a shell of these dimensions is nine-twentieths of an inch. The shell referred by Meek, *Geol. Expl. 40th Parallel*, Vol. iv, p. 78, Pl. VIII, Fig. 4, to *P. longispinus* Sowerby, probably belongs to *P. pertenuis*, for it lacks the medial sinus, and has the other characters of *P. pertenuis*, except that the beak is not quite so slender.

Horizon and Locality.—Lower Coal Measures, four miles north of Vinita; one mile south of Muscogee: Upper Coal Measures, Cavaniol group, McClellan ford on Verdigris river; Poteau group, six miles west of South Canadian; Permian division, upper bed of sandstone four miles west of McDermitt; Pawhuska sandstone, five miles west of Cushing. The same or a nearly related species also occurs in the Lower Carboniferous limestone, Boston group (St. Louis-Chester), five miles southeast of Adair; a specimen from this locality is figured on Pl. XII, Figs. 8, 9 and 10.

Aviculopecten rectilaterarius Cox. Pl. IX, Fig. 6.

Avicula rectalaterarea Cox. *Geol. Survey Kentucky*, Vol. iii, p. 571, Pl. ix, Fig. 2.

The shell is somewhat semicircular in outline, the greatest length being about equal to the greatest width. The hinge line is straight and nearly equal to the greatest width. The beak is small, rounded, does not project above the hinge line. The rounded anterior ear is rather sharply set off from the rest of the shell, and differs slightly from it in having the radial ribs rather coarser and further apart. The left valve has the base of the anterior ear somewhat notched. The posterior ear, which is longer than the anterior, is

not distinctly set off from the rest of the shell, but differs from it in ornamentation, so as to be well marked.

The surface is marked by distinct radial ribs, somewhat narrower than the interspaces. These ribs are often dichotomous, and also increase by intercalation. Near the beak the surface is faintly ornamented with distinct concentric striæ of growth, which grow stronger towards the posterior margin. The ears are ornamented just as the rest of the shell, except that the ribs are somewhat coarser on both anterior and posterior ears.

A. rectilaterarius resembles very closely *A. papyraceus* Sowerby of the European Coal Measures, and indeed a more perfect suite of specimens may show their identity, for many of the species that accompany *A. papyraceus* in Europe have already been found in America.

Horizon and Locality.—Upper Coal Measures, Poteau group, in the shales overlying the Mayberry coal, at the mines four miles northwest of Poteau, Indian Territory.

Schizodus insignis sp. nov. Drake. Pl. IX, Fig. 7.

This species, one of the largest of the genus Schizodus, is represented in the collection only by a cast, so that the generic reference is not beyond doubt. The shell is large, being two and a half inches in length and two inches in height. Convexity of the valve is eleven-twentieths of an inch. The beak is rather high and pointed, rising two-fifths of an inch above the hinge line. The anterior margin is rounded, the posterior is broken off. The anterior and posterior adductor impressions are quite large and distinct. The cast is smooth, so nothing is known of the sculpture of the surface. The only species with which *Schizodus insignis* may be compared is *Schizodus* (*Leptodomus*) *magnus* Worthen, *Geol. Surv. Ill.*, Vol. viii, p. 107, Pl. XVIII, Fig. 2, of the Lower Carboniferous, Chester horizon; but *S. magnus* differs from *S. insignis* in the elongation of the anterior part of the valve, also in the sharp high ridge that runs from behind the beak obliquely to the rear of the shell. Otherwise there is considerable similarity, and the two species may very well belong to the same genus.

Occurrence and Horizon.—In hard sandstone of the Permian horizon, five miles east of McDermitt, Indian Territory; only a single specimen was found.

PART III.

Economic Geology.

The coals of the Indian Territory are at present its most important geologic product. The part of this paper treating of economic geology must therefore be devoted principally to coal.

Coals of the Choctaw Field.

Grady Bed.—The outcrops and workable areas of the Grady coal bed are confined to three continuous narrow belts. One belt encircles the Backbone anticline, one the Bokoshe-Milton anticline, and the other lies at the south bases of the Poteau, Cavaniol and Sans Bois mountains. The bed around the Backbone anticline enters the Indian Territory on the north side of the axis east of Pocola, and runs about S. 80° W. At the Territory line the bed is almost horizontal, or dips slightly to the north, as shown in Section No. 5, which was made across the Backbone anticline southeast of Pocola.

One mile west of Pocola the coal bed dips 15° to 20° to the north; the coal is three feet and seven inches thick, and has one thin parting of shaly coal nineteen inches from the bottom of the bed. Fire clay underlies the coal and arenaceous clay shale overlies it. The increased dip of the coal bed to the west from the Territory line is probably due to the decrease in the throw of the fault along the north side of Backbone mountain, so that the strata enter into the anticlinal fold. It is possible that the Poteau river west and north of Pocola runs along a gentle anticline; if so, the coal bed is deflected down that stream on either side. The dip of the rock west of Pocola, however, does not make this probable. At any rate, a few miles west of Poteau river along the general direction of the coal outcrop, the dip of the rocks shows conclusively that the bed is continued westward from that place. The coal bed has been opened near the Kansas City, Pittsburgh and Gulf Railway at several places on either side of Buck creek prairie and east of Poteau river. This coal is being worked to a very limited extent a half mile east of Poteau river and a half mile south of James fork of Poteau river; the coal at that place is twenty-eight inches thick, dips 10° S. and is overlain and underlain by black clay shale. The bed increases in thickness towards the west, so that a few miles west of Poteau river it is four feet thick. The Bokoshe-Milton anticlinal fold brings this coal bed up so that its outcrop swings

around that anticline. This outcrop has been prospected along most of its length at intervals of one-fourth to one-half mile.

West of Ward the coal is four to five feet thick and dips 25°. Southwest of Ward, at the Coleman place, a well passes through six feet and two inches of coal, including a parting of very shaly coal one and a half inches thick, two feet from the top. One-half mile further south the coal is said to be five and a half feet thick. The dip of the coal bed increases slightly toward the south for a mile or two. South of Bokoshe it is about four feet thick and dips 25°. One and a half miles east of Milton the coal is three feet eight inches thick. A half mile south of Milton, at the Ward Brothers' coal bank, the coal bed is parted by twelve to eighteen inches of shale; the upper stratum of coal is twenty-six inches and the lower forty-four inches thick. Gray clay shale underlies and overlies the coal. A half mile further west the coal bed is parted by five inches of shale, the upper stratum of coal is twenty-two inches thick and the lower four feet two inches thick; the dip is 23°. A half mile still further west the upper stratum of coal is twenty-eight inches thick, the shale parting three inches; only about four feet of the lower stratum of coal was seen, and the bed is a little thicker than that; dip of bed 22° S.

Farther to the west the coal slightly decreases in thickness, while eastward and northward on the north side of the loop it decreases rather rapidly, until it is about eighteen inches thick west of Bokoshe, and about fourteen inches thick northwest of Bokoshe.

This coal bed dips southward under the Sugar Loaf, Poteau, Cavaniol and Sans Bois mountains and comes to the surface again on the south side of those mountains, as shown in Secs. 1, 2, 3 and 4. The coal bed along this south line of outcrops is often split by partings varying in thickness from a few inches to fifty feet, and several thin strata of coal are common near the main bed. The following section, from a railway cut one and a quarter miles south of Heavener, shows the nature of this coal group at that and a number of other places:

	FEET.	INCHES.
Shale	2	
Coal		8
Shale	15	
Shaly coal	1	
Shale and streaks of coal	5	

	FEET.	INCHES.
Coal		6
Carbonaceous shale	1	6
Coal		2
Carbonaceous shale	2	
Coal		4
Carbonaceous shale	1	6
Coal		1½
Carbonaceous shale	1	6
Shale	15	
Sandstone	25	
Shale	12	
Sandstone	5	
Shale	2	
Coal		1
Carbonaceous shale		11
Coal		1½
Carbonaceous shale		6
Coal		2
Shale		3
Coal		1
Shale		2
Coal	1	
Shale	4	
Coal	2	

Three miles east of this section the coal is two feet six inches thick. One and a half miles southwest of Heavener it is twenty-eight inches thick. Three miles northwest of Heavener the coal has been mined considerably and is said to be about four feet thick.

This coal has been mined quite extensively where it is touched and crossed by the St. Louis and San Francisco Railway. At the most easterly point touched by the railway, a place once called Pocohontas, the coal lies in two beds separated by about fifty feet of shale; the upper coal bed is thirty-seven inches thick and the lower one forty-four inches, and the bed dips about 45°.

At Wilburton preparations for extensive coal mining were being made in 1896. The coal occurs in two beds separated by about fifty feet of shale. The upper bed is about four feet thick; the lower one was not accessible in 1896, but the superintendent of the mine

reported it a little over four feet thick. The coal is apparently of uniform good quality. This bed is now being worked extensively at Cherry Vale, about three or four miles northeast of Krebs, where it averages about three feet four inches thick, is uniformly good and dips about 12° N. From this mine the coal outcrop runs but little farther west before it swings to the south and then turns east some twenty miles, when it again swings to the south and back west again, thus forming an S-shaped outcrop at this place. The eastward loop of the S outlines a small synclinal basin called by Dr. H. M. Chance the Grady basin.[1] Coal is extensively mined in this basin at Hartshorne. The coal is composed of one four-foot bed, which is worked, and other higher, thinner beds, not worked. The synclinal fold, forming the basin, is a gentle one so that the dip of the rocks on its sides are only 4° to 5°. Chance[2] says: "The maximum depth of the Grady coal bed in this basin is about 600 feet; but over three fourths of the basin the bed can be reached at depths less than four hundred and fifty feet, and over one-half of the basin the depth will probably not exceed three hundred feet. The basin is about six miles long by three or four wide and contains over 11,000 acres of the Grady bed. Throughout this area the coal is not always of workable thickness; but over a large portion of it the bed will range from three and a half to five feet thick, yielding an average of four feet of clear coal."

This coal outcrop west of Hartshorne is so broken by faults and tilted by very irregular folds that it is not easily located. The three-foot bed of coal that outcrops in Brushy creek, about five miles west of Hartshorne, appears to be the Grady bed. Here it shows a fault of four or five feet and dips to the southwest 5° to 6°. About two miles further west, that is, seven miles west of Hartshorne and one-fourth of a mile northeast of the Brunton place, this coal outcrops again and is three feet eight inches thick, but with two partings of shaly coal in it. One three to four-inch parting is within three inches of the base, and ten inches from the base of the bed there is a shaly parting from one to two inches thick.

McAlester Coal Bed.—The outcrop of the McAlester coal bed is greater than that of the Grady bed, since it does not lie so deep and does not require such excessive foldings to bring it up or such profound erosion to reach it. The outcrop is shown on Pl. I

[1] *Trans. Am. Inst. Min. Eng.*, Vol. xviii, p. 654.

[2] *Ibid.*, p. 659.

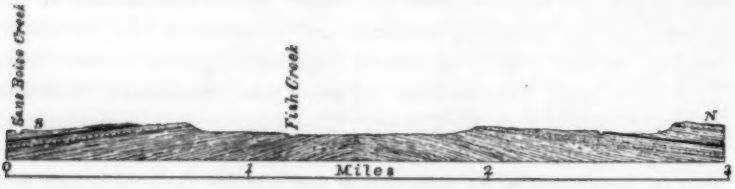
with the exception of areas near the Canadian and Arkansas rivers and around the base of Sugar Loaf and Poteau mountains. These latter places were not sufficiently examined to locate the line of outcrop. This coal bed varies in thickness from about one and a half to about four feet. The thickest part of the bed is in the southwest part of the field or about McAlester, Krebs and Alderson. It appears to thin gradually eastward and northward. In the northern part of the field it is almost regularly eighteen inches thick. This bed is now, and has been for some time, extensively mined at Alderson, Krebs and McAlester. The coal bed at Alderson and Krebs is about three feet six inches thick. One-half mile southwest of McAlester, at D. Edwards & Son's mine, the coal is four feet thick. The dip of the coal bed from Alderson to McAlester varies from about 6° to 25°; the gentler dips are at and near Krebs. The outcrop northwest, north and east of McAlester for some distance lies along a faulted area, so that the coal bed occurs in blocks dipping irregularly and usually at very steep angles. In this faulted area no place has yet been worked extensively and profitably. Farther to the east the coal has not been found sufficiently thick to pay for working. Southeast of Red Oak it is two feet thick and dips 20°. North of Red Oak, in Brazil Creek valley, it is about two feet thick and dips very gently.

At and near Fanshaw the coal is thirty inches thick, dips about 25° and was once considerably but unprofitably mined. About five or six miles east of Fanshaw, in Big Caston creek, the coal is twenty-eight inches thick and dips 35°. The coal once mined at the west edge of Poteau seems to be this bed; it is said to be about two feet thick at that place.

About two and a half miles southwest of Cameron this coal is eighteen inches thick and dips to the southward 2° to 3°. It is occasionally mined to a limited extent by stripping. At this place there is a shale parting in the bed six inches from the base of the coal. In wells on the farm of Mr. Henry Choate, about four to four and a half miles west of Brazil, this coal is reported to be from two to two and a half feet thick. About three miles south of Milton, in Owl creek, near its mouth, this coal bed is eighteen inches thick; some six miles further west in Owl creek, one-fourth mile east of Haney Smith's, the coal is only thirteen inches thick; the dip of the bed about 20°.

Southeast of Sans Bois, along Mountain Fork of Sans Bois creek,

the coal is a little more than a foot thick at the places where it was seen. About three miles west or north of west from Sans Bois, on a branch of Fish creek, in Mr. Scott's pasture, this coal is seventeen inches thick; dips 4° to 5° N. 10° W.



Sec. 14. Across the Sans Bois anticline, four miles west of Sans Bois.

The above cut shows the structure four miles west of Sans Bois. About seven miles west of Sans Bois, in Beaver creek, the coal is fifteen inches thick. About four and a half miles east-northeast from Sans Bois and one-fourth of a mile east of Mr. Ben Noel's place, this coal is eighteen to twenty inches thick; four miles north-northeast of Sans Bois, in the banks of Sans Bois creek, it is eighteen to nineteen inches thick. About three miles north of Sans Bois, along Cedar creek, the coal is eighteen to twenty inches thick, and dips, 5° to 10°. Two miles west of Iron Bridge this coal is twenty-six to twenty-seven inches thick and quite uniform throughout. About four miles west-southwest from Cashier the coal is eighteen inches thick. Two miles west of Stigler, in Cane prairie, the coal is twenty-eight inches thick and of excellent quality. On Rock branch, one mile west of Whitefield, the coal is twenty-seven to twenty-eight inches thick. The Canadian river, north and northeast of Whitefield, appears to run along an anticlinal fold. If this is the case, the east end of the coal outcrop, west of Whitefield, follows down the east side of Canadian river valley and joins the coal outcrop running northward from east of Whitefield; the westward extension of the coal outcrop, west of Whitefield, ascends Canadian river valley probably nearly opposite Brooken before crossing that river and running back east and northeast by Starvilla, as seems to be the case.

Mayberry Coal Bed.—This coal was not located in the Sugar Loaf or Poteau mountains, but it is doubtless represented there. The coal in the east end of San Bois mountains, at some three hun-

dred to four hundred feet above the base of the mountains, and that on the north side of the mountains near the west end, probably belong to this bed. Sans Bois mountains were not studied closely enough to outline the coal outcrop. The final disappearance of the Mayberry bed, under the westward dipping strata, is shown by the coal outcrop located west and southwest of Enterprise. This coal bed is being mined quite extensively in the east end of Cavaniol mountain by the Kavanaugh Coal, Coke and Railway Company. The bed at this place averages about three feet eight inches in thickness and dips slightly to the southwest. On the opposite side of the cañon, from where it is worked and about one hundred and forty feet lower, there is what appears to be another bed of coal. This lower bed contains some shale, as is shown by the following section:

	FEET.	INCHES.
Coal		5
Clay shale		1½
Coal	1	
Shale		9
Coal	2	6

The layers of shale found in this lower bed and its difference in elevation indicate a different horizon from the one that is being worked, but it seems possible, from the cursory examination made, that they may be the same bed. If they are not the same bed, the lower or more shaly bed is probably a local deposit, for but one coal bed of importance was found at other places over the field at the horizon of the Mayberry coal.

On the north side of Cavaniol mountain, at the original place of discovery of the Mayberry coal, the beds show the following sequence:

	FEET.	INCHES.
Coal	1	5
Clay shale		3
Coal		8
Clay shale		3
Coal	1	10

This coal is a short distance above the fourth thick sandstone bed of the Cavaniol mountains.

A coal bed eighteen inches thick outcrops in the northeast end of

Sans Bois mountains one mile south of Henry Blaylock's house and three hundred or four hundred feet up on the mountain side. It is quite uniformly good except one and a half inches of shaly coal three or four inches from the bottom of the stratum. The coal is overlain by sandstone and underlain by clay. This coal was traced one-half mile or more around the hillside and was about the same wherever it was seen. From its position it seems to belong to the Mayberry coal bed. The coal near the head of Ash creek and near the west end of the Sans Bois mountains is said to be about eighteen inches thick. The bed that appears to represent the Mayberry coal, along the western border of the folded area, is from eighteen to twenty-four inches thick and of a good quality. About four miles northeast of Reams, at the west end of Sans Bois prairie, this coal is twenty-four inches thick. The bed is very much fractured at this point, which is on the axis of the Sans Bois anticline. About eight miles south of Enterprise and one and a half miles southwest of Russelville, along the head waters of Old Town creek, the coal is twenty-nine inches thick, including a thin parting of shaly coal eight inches from the base and another seven inches from the top. On the southwest side of McChar mountain, along the head waters of Long Town creek, the coal is nineteen inches thick. One-half mile above the mouth of Old House creek, it is twenty-one inches thick. The coal outcrops on Haytubya creek one-half mile from its mouth and about six miles west-southwest from Enterprise. At this place it is twenty-three inches thick and good throughout, but closely fractured by lines a half to one inch apart; dip of bed 2° to 3°. About four and a half miles west-southwest from Enterprise, the coal has been worked to some extent by stripping. At that place it is twenty-two inches thick and uniform throughout. One and a half miles north of Enterprise, the coal is twenty-six inches thick and is worked for local demands by stripping.

Coals of the Cherokee and Creek Nations.

In those parts of the Indian Territory lying within the Cherokee and Creek Nations the coal beds were not traced in detail, and were seen usually only at widely separated intervals, and cannot therefore be definitely outlined in this discussion. However, the structure of the area is quite regular, so that the general extent and connections of the various coals can be fairly well outlined.

Grady Coal.—The lowest coals found through the Cherokee and Creek Nations will be discussed under this heading, though it is doubtful whether they represent the northern continuation of the Grady bed, or whether they all belong to the same bed. The northern and eastern limit of the Cavaniol group, as outlined on the accompanying map, shows the approximate outcrop of this coal bed. The following local developments were seen: About one mile east of Little Salisaw creek, and one-fourth of a mile south of the Kansas City, Pittsburgh & Gulf Railroad, this bed of coal outcrops and has been worked to some extent by stripping. The coal is said to be one and a half feet thick and of good quality. The strata overlying the bed dip 15° to 20° north-northwest. About three miles southwest of Salisaw Station the same coal outcrops along Coal creek. It is one to one and a half feet thick, and has been mined by stripping. This coal was, in the summer of 1896, being used by blacksmiths in Salisaw, who pronounce it an excellent one for their work. The mines were all filled with water at the time the writer visited the place. Along the south side of Spaniard creek, at the Weber's Falls-Muscogee road crossing, the coal bed is ten to twelve inches thick and is mined for local demands. The bed dips north-northwest about 12°. Going from this point toward Muscogee, the synclinal basin is crossed at right angles and the coal outcrop is again seen about four miles southeast of Muscogee. The eastern end of this synclinal fold lies near Braggs, where the bed has been worked a little. It outcrops along branches about two miles south of Braggs, and is four to six inches thick. It is said to underlie Braggs at an average depth of about thirty feet and is six inches thick. Five miles west of Muscogee and one mile south of the Arkansas river, this coal has been worked a little. At that place the coal is eight to twelve inches thick. It outcrops again four miles north-northwest of Adair, along the side of an east-facing escarpment. Where it was seen (the Ross coal bank), the coal is seventeen inches thick, underlies a gray shale and is apparently rather high in ash and sulphur.

This coal outcrops along Log Cabin creek, about three miles west of Welch, where it is said to be about two feet thick, and is mined for local demands.

McAlester Coal Bed.—This coal outcrop is approximately located on the map from near Starvilla to Dirty or Elk creek, northeast of Checotah. One and a half miles northwest of Starvilla the coal

is about two feet thick. It is mined to some extent along the Thomas fork of Elk creek, at a place about six miles east of Checotah, where it is about fourteen inches thick. Along Elk or Dirty creek, about four miles east of Checotah, the coal is eighteen to twenty-four inches thick. From Starvilla to Elk creek, and doubtless much farther, a five to six-inch seam of coal occurs regularly fifty to seventy-five feet above the McAlester bed. These beds in the Choctaw coal field are separated by about one hundred feet of gray clay shale.

The McAlester coal outcrops six or seven miles southwest of Muscogee, where it is about one foot thick and is worked for local demands.

Another outcrop was seen four or five miles west of Chelsea, where it was worked at several places for local demands. At the Robinson bank it is eighteen inches thick, and of uniform quality throughout. At the McFadden coal bank the same qualities are shown.

About a hundred feet above this bed and four miles farther west, a coal bed fifteen inches thick outcrops. It is also worked somewhat for local use by stripping. This bed is probably not represented south of the Canadian river, but the outcrops along Coal creek, twelve miles east-northeast from Okmulgee, and those five to six miles southwest of Chelsea, are probably the same. On Coal creek the coal is about fifteen inches thick and quite uniformly good. The bed dips 1° to 3°, is overlain by carbonaceous clay shale, and underlain by fire clay. Southwest of Chelsea the coal is about ten inches thick and of very good quality.

Mayberry Coal Bed.—The coals occurring at the top of the Cavaniol group, and that probably represent the northern extension of the Mayberry bed, were seen as follows:

The upper bed outcrops along Coal creek, twelve miles south of Okmulgee, where it is parted by from four to eight inches of shale and shaly coal. The upper stratum of coal is fourteen inches thick and the lower one is from fourteen to sixteen inches thick. Both strata are apparently good, but iron pyrites is rather common in places through the coal. In general appearance this coal is almost identical with that occurring four or five miles west of Chelsea, and the chemical analyses show them to have the same general properties. The next outcrop of this coal bed was seen along Coal creek, about six miles east of Sapulpa. At that place it is from twenty-

two to twenty-four inches thick where it was examined, and has three to four shale partings, which are from a quarter to half an inch thick. Gray clay shale overlies the coal. The Mayberry coal bed was seen next at a place three miles northwest of Oologah, where it is two feet thick and rather uniform throughout. It is mined rather extensively by stripping for shipping to distant markets as well as for local demands. This same bed outcrops along Little Verdigris or Caney river at Mustgroves crossing, where it is about one and a half feet thick, according to report.

These local developments show that the best coals of the Cherokee and Creek Nations are only about two feet thick, but that they extend through the entire length of the Nations.

Coal Analyses.—At each locality where coals were collected for analyses, samples were selected to represent the average coal of that particular place; but as no guide save the appearance of the coal could be used in sampling, the analyses will necessarily not show the quality of the coal as well as may be desired. They will, however, show fairly well the characteristics of the coals and their adaptability to various uses. In the table of coal analyses the coal beds are placed in the same relative position that they occupy in the field, so that the Mayberry coals are first or at the top, the McAlester coals in the centre, and the Grady coals at the bottom. In each group the analyses begin with coals in the west and northwest part of the field and proceed eastward and southeastward. The groups thus proceed from higher to lower coals; the analyses of each group, and the groups also to some extent, run from a region of less to a region of greater folding and crushing. This arrangement clearly shows the decrease in the bituminous nature of the coals toward the region of greater dynamic movements. The coals are practically all bituminous, only that from near the mouth of James fork of Poteau river and that from near Milton being semi-bituminous. All the coals show a probability of coking, and a considerable quantity of slack coal from mines at Alderson and Krebs is now being coked. Most of the coals, however, are too high in sulphur to produce good coke for metallurgical uses. Some of the coals are objectionably high in sulphur, water, or ash, but as a whole they compare favorably with good coals from other fields.

Coal Oil.—During the summer of 1896, several wells were sunk, two hundred to three hundred feet deep, along Spencer creek val-

Coal Analyses by N. F. Drake.

Bed.	Locality.	Thickness of Coal Beds.	Water.	Volatile Hydro-Carbons.	Fixed Carbon.	Ash.	Sulphur.	Fuel Ratio.	Color of Ash.	Coking Tests.	Remarks.
Mayberry Bed.	Three miles northwest of Oologah, Cherokee Nation.	1′ 0″	3.35	34.99	57.88	3.15	1.21	1.65	Light yellow.	Fused and doubled in size.	
	Four miles east-northeast from Reams, Choctaw Nation.	2′ 0″	1.62	32.92	55.79	9.65	. . .	1.69	Lavender.	Fused and increased one and a half times.	Sulphur not determined.
	Twelve miles south of Okmulgee, Creek Nation.	2′ 4″	6.31	30.78	59.92	2.11	0.87	1.94	Light yellow.	Fused and increased in size one and a half times.	
	Six miles west-southwest of Milton, in north end of Sans Bois mountains.	1′ 6″	0.95	31.71	57.75	9.57	. . .	1.82	Brick red.	Fused and increased in size about ten times.	Sulphur not determined.
	Four miles northwest of Poteau, Choctaw Nation.	3′ 8″	1.36	17.23	64.54	12.46	4.40	3.80	Reddish brown.	Fused and increased in size about ten times.	
	Eight miles west of Chelsea, Cherokee Nation.	1′ 3″	2.77	34.61	56.17	6.43	. . .	1.62	Brick red.	Fused and increased in size about five times.	Sulphur not determined.
McAlester Bed.	Four and a half miles west of Chelsea, Cherokee Nation.	1′ 6″	6.26	27.16	64.17	1.84	0.56	2.36	Yellowish white.	Fused and increased in size one and a half times.	
	One-half mile southwest of McAlester.	4′ 0″	3.33	29.75	61.78	4.37	0.75	2.07	Yellowish brown.	Fused and increased one and a quarter times.	
	Alderson, Choctaw Nation.	3′ 4″	2.35	32.42	58.47	4.32	2.42	1.80	Light lavender.	Fused and increased in size one and a half times.	
	Three miles north-northwest of Sans Bois.	1′ 6″	1.60	24.83	68.69	2 95	1.90	2.76	Reddish brown.	Fused and increased in size about ten times.	
	One and a half mile northwest of Starvilla, Cherokee Nation.	2′ 0″	1.25	22.49	62.18	7.88	6.18	2.77	Brick red.		
	Two miles west of Stigler, Choctaw Nation.	2′ 4″	1.66	23.01	72.49	1.92	0.91	3.15	Light yellow.	Fused and increased in size about ten times.	
	Two miles west of Iron Bridge.	2′ 3″	1.21	19.67	73.46	3.40	2.25	3.75	Brick red.	Fused and increased in size about ten times.	
Grady Bed.	Cherry Vale mine, Choctaw Nation.	3′ 4″	2.54	30.90	62.37	3.56	0.60	2.01	Yellowish brown.	Fused and increased in size very little.	
	Hartshorne.	4′ 0″	2.69	35.65	54.91	4.12	2.62	1.54	Reddish brown.	Fused and increased in size one and a half times.	
	Upper stratum of coal bed, one-half mile south of Milton.	2′ 2″	1.12	14.23	77.31	4.04	3.28	5.43	Lavender.	Fused and increased in size about eight times.	
	Lower stratum of coal bed, one-half mile south of Milton.	4′ 2″	0.98	13.60	73.84	7.83	3.72	5.43	Lavender.	Fused and increased in size about eight times.	
	One and a half mile southwest of Heavener.	2′ 4″	3.67	19.46	72.83	3 28	0.74	3.74	Light yellowish brown.	Fused and increased in size but very little.	
	Near the mouth of James fork of Poteau river, Choctaw Nation.	2′ 4″	1.20	13.75	82.95	1.16	0.92	6.03	Yellowish brown or nearly orange.	Fused but increased very little in size.	

ley, four to five miles west of Chelsea. Some of the wells flow, but none of them produce very much oil. The foreman of the works informed me that the greatest flow of any one well was about a barrel per day, and that the oil was struck in a micaceous shaly sandstone. This sandstone is probably the bed that outcrops east of Chelsea, and lies between the two lower coal beds. The rock beds are practically horizontal in the area where the oil wells have been sunk, but the strata passed through, in sinking the wells, come to the surface farther eastward. The oil is probably derived from the Lower Coal Measures shale beds that outcrop along the Missouri, Kansas & Texas Railway, east of Chelsea.

Building and Ornamental Stone.—The sandstones, limestones, marbles and granite that occur in this field are adapted to many uses in construction work. Sandstones are very abundant, except in the Boone chert area, throughout almost the entire field. They are usually evenly textured, massive, tough, and are well adapted for ordinary building purposes. The best limestones for building purposes are confined to the Lower Carboniferous and especially to the upper Boone limestone horizon. Massive beds of tough gray evenly-textured limestone are common in the Boone limestones. The Boston group also contains some good building limestones and occasional thin beds of limestone were seen in the Permian area that are fairly good for building purposes. The outcrops of the marble beds are shown in Pl. IV. Massive beds of marble, twenty-five to thirty feet thick, outcrop at nearly every marble area shown in that plate. The thickness of the marble beds has not yet been determined, but from drill borings it appears to be one hundred and fifty feet or more. The marble is usually pink colored, but some of it is gray and a little is practically white. So far, the marble that has been quarried contains a great many fractures and rather abundant small cavities, partly or entirely filled with large calcite crystals. Further investigation may result in finding better marbles than the surface outcroppings. Some of the bed that is at present being quarried can be advantageously used for building and ornamental uses.

The granite found on Spavinaw creek is an excellent stone for building and ornamental purposes, but it is at present too far from any railway to be profitably quarried for marketing. For a more extended discussion of the various kinds of rock previous pages may be consulted.

Stated Meeting, September 17, 1897.

Vice-President PEPPER in the Chair.

Present, 16 members.

Correspondence was submitted and donations to the Library were reported.

The announcement of the decease of William S. Baker, a member of the Society, on the 8th day of September, æt. 74 years, was made.

Mr. R. P. Field presented a communication on "The Span of Life."

Mr. Henry C. Mercer made some remarks on the "Survival of the Art of Illuminating Manuscripts among the Germans in Eastern Pennsylvania."

The Committees on By-Laws and Finance presented reports.

The Society was adjourned by the presiding officer.

THE SPAN OF LIFE.

BY ROBERT P. FIELD.

(*Read September 17, 1897.*)

On Thursday, February 28, 1895, the *Evening Bulletin*, a daily journal published in Philadelphia, had an editorial upon long life in Philadelphia, referring to an address by Dr. Lawrence Turnbull on "Longevity and Personal Hygiene," in which he presented an array of facts with regard to the advanced age of some of our best known men, and said: "The Biblical idea of three-score years and ten is gradually ceasing to be the limit in our day, owing to better sanitary laws and regulations," which this journal states is in direct opposition to the common belief that, in the United States at least, the activity and restlessness of the people are tending to shorten the period of life enjoyed by the average man. This belief, it says, is entirely reasonable owing to the greater hurry and cram of the people of this country, and in view of the fact that they sleep less and hurry more over their food than do the people of other nations.

The editorial goes on to say, for instance, that the late Dr. Oliver Wendell Holmes believed that the life of a poet is generally not long; yet refers in his writings to Longfellow, Halleck and Whittier, all of whom attained to over seventy-five years of age and one of them to eighty-five, and that Holmes himself was eighty-five when he died. Other well-known men are cited by Dr. Turnbull as examples of longevity; for instance, Mr. Gladstone living at eighty-five, Bismarck at eighty, Pope Leo XIII at eighty-five, and in our country Senator Morrill, of Vermont, eighty-four; ex-Senator Payne, eighty-five; Neal Dow, of Maine, ninety-one; Robert C. Winthrop, eighty-seven; ex-Secretary McCulloch, eighty, and ex-Senator Thurman, eighty-one, in addition to whom he mentions Dr. William H. Furness and the Hon. Frederick Fraley. The apparent conclusion reached by the paper is that long life in America is not uncommon, and that, therefore, the average age is greater than the so-called three-score years and ten.

This editorial was penned more than two years ago. My attention was called to it by Dr. J. Cheston Morris, who knew that I was interested in such matters. The remark by Dr. Turnbull on the "Biblical idea" aroused my curiosity and a desire for investigation. As some of the names mentioned in this paper appear upon the rolls of the American Philosophical Society, it seemed as if the "experience" of the Society in this direction would be interesting. The "experience" of the Society does *not* bear out the assertion of Dr. Turnbull if his statement be taken to mean that nowadays the average life is greatly prolonged beyond the "three-score and ten."

In the general list of the members of the Society from 1743 to 1894, inclusive, there have been 1118 deaths where the ages have been recorded. The average age at death is seventy and one-eighth years. The youngest age is twenty-five (25) years. Two deaths are recorded at that age, Dr. John Pennington and Joel B. Reynolds. The oldest age at death was Dr. Ed. Holyoke, of Massachusetts Bay, having died at the advanced age of one hundred and one (101).

The average length of membership is found to have been twenty-two and sixty-four one-hundredths years (22.64). The shortest membership is that of Capt. Karl Chevalier Rousseau d'Happoncourt, who was a delegate from K. K. Military and Geographical Institute of Vienna on the occasion of the Society's sesqui-centen-

nial, was elected to membership October 20, 1893, and unfortunately died only six days afterwards, on the 26th.

The longest membership was that of Thomas Bradford, who was elected May 18, 1768, at twenty-three (23) years of age and died on May 7, 1838, at ninety-three (93), having been a member seventy (70) years, less eleven days.

Six cases show a membership of sixty-five (65) years and over.

The average age at entry (or at election) was forty-seven and forty-nine one-hundredths (47.49) years.

From the *record* it would appear that several persons were elected at a very early age—Rev. Henry Steinhauer as early as thirteen (13), but there are so few that this error (if it be one) could not affect the general finding.

The general deduction from this study shows:

1118 members entering at an average age of....47.49
1118 members living after election a total of 25,312 years or averaging.....22.64
1118 members living 78,403 years or averaging at death.....70.13

It is exceedingly interesting and instructive to note that comparng this with the "American Experience Table of Mortality," calculated from the experience of the insurance companies, we find that

Persons living at the age of forty-seven and a half.....47.50
May be expected to live for twenty-two seventy-two one-hundredths years.....22.72
Or to reach the average age of.....70.22

But the editorial refers to "the common belief that, in the United States at least, the activity and restlessness of the people are tending to shorten the period of life enjoyed by the average man." In order to see whether the American members live a shorter time than others, or whether the "leaven" of the foreign element has increased the apparent longevity, a study was made of the "experience" of the American members alone for twenty-five years.

The record was studied with reference to the deaths which have occurred during the twenty-five years ending December 31, 1894. Three hundred and fourteen (314) members died during this period. the ages of two hundred and ninety-three (293) of whom are known

The result of the study of these shows:

Two hundred and ninety-three members entering at an average age of.....48.57
Two hundred and ninety-three members living after election a total of 6253 years, averaging.21.34
Two hundred and ninety-three deaths of members living a total of 20,484 years, or averaging.....69.91

Even this small number shows a fairly close agreement with the tables.

This shows practically the same result as that given above. This result bears out the mortality tables and the "Biblical idea."

The table shows that people aged.....48.57 years
Might be expected to live.....22.00 "
And reach the age of.....70.57 "

which is but sixty-six one-hundredths of a year longer than this actual "experience," a variation easily accounted for by the small number making up the "experience."

Some years ago I had occasion to look up the "experience" of clergymen in connection with some of the different Protestant denominations. In this study the records of eight denominations were consulted, involving seven thousand six hundred and twenty-two (7622) lives, who lived 495,967 years, or an average of 65.07 years.

The average age at which a man enters the ministry is from twenty-five (25) to thirty (30) years, averaging, say, twenty-eight (28) years.

By looking at our "American Experience Table" again, we find the "expectation"

For those entering the table at twenty-eight years is.....37 years
If we add the entering age to this.....28 "
We get.....65 years

which is almost exactly the experience of these ministers.

Returning to the records of the Society we find that on December 31, 1894, the longest term during which any one still living had

been a member was fifty-five (55) years, Mr. Martin H. Boyé, who was elected January 17, 1840, being still alive. The next longest term was that of Prof. E. Otis Kendall, LL.D., who was elected January 21, 1842, or fifty-three years previous. Our President, Hon. Frederick Fraley, LL.D., was elected July 15, 1842, and had lived for fifty-two and one-half years. The average length of membership of the living members on that date was sixteen and one-half years (16.05), but this count includes only the American members, of whom there were three hundred and thirty-seven (337).

While to a certain extent the average health may be improving, it will take long periods of time for the predictions of physicians to falsify the mortality tables. In this connection it might be well to note that the records of the Board of Health of Philadelphia show that, one year with another, while improved sanitary conditions modify the fatality of certain zymotic diseases, the death rate in Philadelphia remains practically stationary and at about two per cent.

THE SURVIVAL OF THE MEDIÆVAL ART OF ILLUMINATIVE WRITING AMONG PENNSYLVANIA GERMANS.

BY HENRY C. MERCER.

(*Read September 17, 1897*).

The notion of a novel collection was suggested to me by a visit paid last April to the house of an individual who has long been in the habit of buying "penny lots" of so-called trash at country sales. There, scattered in confusion about the premises, rusting, warping and crumbling, lay a heterogeneous mass of objects of wood or iron, which by degrees I recognized as of historic value. Forgotten by the antiquary, overlooked by the historian, they were the superannuated and cast-away tools of the Pennsylvanian pioneer. Because they illustrated, with the fidelity of visual facts, the felling of the forest, the building of the log cabin, cooking in the open fire and the disused arts and crafts, professions and amusements of colonial times, I gathered them together and, ransacking Bucks county for other specimens, stored them by the wagon-load in the museum of the Bucks County Historical Society, at

Doylestown, as a novel and hitherto unattempted illustration of the American beginning.

Among the manifold suggestions involved in the genealogy of such objects as the reaper's cradle, the American carpenter's hatchet and pitching axe, the Dutch scythe and the wooden plow, carrying investigation from America to various parts of Europe, a rude, lidless paint-box, fastened with wooden pegs, long puzzled us.

FIG. 1. Paint box used by German schoolmaster about 1820 in the execution of Fractur or illuminative German handwriting. Museum, No. 103, Bucks County Historical Society. Presented to the Society by Tobias Nash, of Wormansville.

About a foot long by six inches broad, with several compartments containing little glass bottles, it was finally explained as one of the color-boxes of teachers of the German schools, superseded in Bucks county fifty years ago. Using it as a receptacle for their home-made pens, brushes and colors, they had instructed scholars in the art of Fractur or illuminative handwriting until about the year 1840.

With great interest, we learned that the time-stained box found in one of the garrets of Bedminster had long ago in its longest compartment contained goose-quill pens, and brushes made of the hair of the domestic cat; that the caked colors in the small bottles had been the home-mixed inks and paints of the master once liquefied in whisky, and that the varnish was composed of the gum of the cherry tree diluted in water.

Working with these primitive tools, often lit at his task, let us suppose, by the once familiar boat-shaped lard lamps suspended upon trammels of wood, the pioneer schoolmaster at the log schoolhouses produced in the latter part of the last century and the

beginning of this, the beautiful illuminated hymns (see Plate V) and ornate title-pages which when found in numbers among Mennonites in central Bucks county astonished and delighted us for the first time in August, 1897.[1]

These glowing relics of the venerable stone farmhouses of eastern Pennsylvania, sometimes falling to pieces through carelessness, sometimes preserved with veneration between the leaves of large Lutheran Bibles, revealed by degrees to our investigation the following facts:

First, That the art of Fractur was not confined to Bucks county or to the Mennonites, who had presented us with the first specimens seen, but that it had flourished throughout Pennsylvanian Germany, among the Dunkers, the Schwenkfelders and probably the Amish and Moravians.

Second, That it had been chiefly perpetuated by deliberate instruction in German schools by German schoolmasters, and that it had received its death blow at the disestablishment of the latter in Bucks county in 1854.

Third, That the art, always religious, had not been used for the decoration of secular themes, such as songs, ballads or rhymes, but had expressed itself in

A. Illuminated Song Books,

Such as the beautiful manuscript song books called *Zionitischer Rosen Garten*, and *Paradisisches Wunder-Spiel*, made by the monks at Ephrata, and presented by Mr. Abram H. Cassell to the Pennsylvania Historical Society.

B. The Title-pages to Small, Plain Manuscript Mennonite Song Books,

Often giving the owner's name, with the date and the writer's school, with illuminated borderings, overhanging tulips or lotus, birds and angels blowing trumpets. For example:

[1] The observation was made while my *Tools of the Nationmaker* was in press, on August 20, 1897. I called attention to the special discoveries made in Bucks county in *Science* (See *Survival of the Art of Illuminating Manuscripts among the Germans in Eastern Pennsylvania*, September 17, 1897), at a special meeting of the Bucks County Historical Society at Doylestown, October 7, 1897, and in *Tools of the Nationmaker*, published by the Bucks County Historical Society, Alfred Paschall, Doylestown, 1897, under the numbers 103, 633, 689, 726.

1. Leaflet 8¼ inches long by 6¾ inches broad. Name. Words, *Dieses Vorschrifften Buchlein Gehoret Margretha Wismerin Schreib Schuler in der Birchenseher Schule* (now Blooming Glen). *Vorgeschrieben der October 4te, 1781.* Above a short prayer, surrounded with admonitions to diligence. In rectangle, formed of ornate foliated borders, are three feathered crowns and two angels holding tulips and blowing trumpets. Tulip stalks spring from hearts. Colors, blue, green, red, yellow and black. Probably made in the last century by Jacob Overholt, teacher in a log schoolhouse near Deep Run, Bucks county, Pa. Presented to the writer by his descendant, David Landis, of Plumsteadville.

2. Title-page to church song book (*Lieder Buch*, printed in Germantown, Michael Villmeyer, 1811). Name, Susanna Fretz, upon heart, from which springs a tree with the conventional tulips. Deep beaded bordering, 1814. Colors, red, yellow, brown and black, red predominant.

3. Title-page to manuscript song book. Name, Susanna Fretz (spelled *Fretzin* for feminine) in red circle, with date, 1810. Stalks, with black leaves and conventional tulip to right and left. Foliated border with red leaves on black and yellow ground.

4. Illuminated card on blank page of same hymn book. Above name, Susanna Fretzin, heart, from which rises conventional tulip. In possession of Henry W. Gross, Doylestown.

5. Title-page to manuscript hymn book. Name, Joseph Gross; illuminated letters, foliated capitals. Date, April 20, 1830. Double tulips in foliate border on yellow ground.

6. Title-page to manuscript hymn book. Name, Sarah *Wismer*. Foliated capitals, conventional flowers on heavy stalks. Date, 1827. Colors, yellow, red, brown and blue.

7. Title-page to ditto. Name, Elizabeth Nesch, spelled *Neschin;* with words, *Dieses Sing-Noten Buchlein Gehoret Mir. Sing Schuler in der Bedminster Schule. Geschrieben, September 6ten, im Jahr, 1799.* Three tulips. In possession of Joseph N. Gross, Doylestown.

8. Title-page to similar book, with tulips floriated capitals, and name, Stauffer. In possession of Isaac J. Stover, of New Britain.

C. Rewards of Merit on Loose Leaflets.

About a Foot Long by Eight Inches Broad.

First there is a text of Scripture, with elaborately illuminated characters, and done in many colored inks, under which a bar of music may set the tune to a German hymn, engrossed in many verses below. From this rich, floriated text, with its adorned and highly colored borderings, emerge birds, twining stalks growing from symbolic hearts bearing tulips, or angels blowing trumpets. Examples are:

1. Leaflet, 13¼ inches long by 8⅜ inches wide, with floriated text, *Allda Kreuzigten Sie Ihn.*, etc., etc., nineteenth chapter of John, eighteenth verse,

Luther's translation (see Plate V). Above, single bar of music, with red lines heading hymn and six verses beginning, *O fröliche Stunden, O herrliche Zeit.* Under this the alphabet in common German handwriting, capitals and small letters, with Arabic numerals up to a hundred. Below, to the left, transverse rhymed admonition in red and black ink, beginning *Ach lieber Mensch.* Two birds are set upon the text of the hymn. The capital letters are elaborately illuminated and surrounded with scrolls. The bordering to the left is colored with a design. In the possession of Henry W. Gross, Doylestown. Date probably from 1760 to 1790.

2. Similar leaflet. Text, one hundred and third Psalm, verses nine and thirteen, in German. Hymn and six verses. Alphabets, numerals and admonition arranged as before. Elaborately illuminated capitals and colored borderings, birds, scrolls and tulips. Colors, red, brown, blue, green yellow and black. Name Christian Gross, in rectangle. Date probably about 1760. In possession of Isaac Gross, of Bedminster.

3, 4. Two similar leaflets, closely resembling each other. Text, Philippians i. 23. Hymn in five verses. Admonition, alphabets and numerals omitted. Capitals more elaborately floriated than before. Conventional leaves, flowers, tulips and birds. Colors, red, blue, green, yellow and black. Ornate borderings with heart pattern. Name, Isaac Gross, on corner of one specimen. Made by Isaac Gross, of Bedminster, related to the owner, born 1807, died 1895. Date about 1840, or earlier. In the possession of Henry K. Gross, of Plumsteadville.

5. Leaflet, slightly smaller (see Plate VII), with hymn or sacred verse in six rhymed lines, beginning *Jesus soll mein Jesus bleiben*, intertwined with numerous leaves bearing flowers. Elaborately scrolled capitals and four birds over the name of the maker, Isaac Gross, January 10, 1830. Colors, green, red, brown, blue and black. In possession of Henry K. Gross, of Plumsteadville.

6. Leaflet, 11¾ inches long by 7¾ inches broad. Text, Proverbs xiii. 7. Below this, a prayer on the theme of poverty. Capitals set in rectangles filled with pen hatchings. Colors, red and black, with a little green. Date about 1760 or earlier. In possession (1897) of Isaac Gross, of Bedminster.

7. Leaflet, 13 inches long by 8 inches wide. Pious rhyme of admonition to children, beginning *Die Kinder Lieb ist Wunderlich*, with elaborately illuminated capitals, scrolls, leaves, a bird and several tulips. A separate admonition in small ovate enclosure to the right, colored borders with alphabet below. Colors, blue, red, yellow, green, brown and black. In possession of John Walters Chalfont.

D. Book Marks.

Sometimes consisting of such designs as tulips springing from hearts, conventionalized trees, or religious symbols. Examples are :

1. Leaflet, 6½ inches long by 3¾ inches wide. Two conventional trees with red stalks, and lanceolate green leaves. Border, yellow and red. No writing. In possession of Henry K. Gross, Plumsteadville. Date, about 1830.

PLATE V (half size).—Illuminated leaflet in the possession of Henry W. Gross, of Doylestown. The floriated text is Luther's translation of John xix, 18. *Allda Kreuzigten sie Ihn*, etc., etc. Below it is a bar of music with red lines heading a hymn of six verses beginning "*O fröhliche Stunden O herrliche Zeit*," and beneath an alphabet and numeral series. A pious rhyme beginning "*Ach lieber Mensch*" forms the lower, left border. Colors red, black, blue, yellow, brown and green.

PLATE VI.—Illuminated leaflet with text in Philippians i, 23, and hymn. In possession of Henry K. Gross, of Plumsteadville.

Plate VII. Illuminated leaflet with hymn, and date, 1830. In possession of Henry K. Gross, of Plumsteadville.

2. Conventional bird, the pelican (a mediæval church symbol emblematic of the Redemption), standing upon bracket protruding from urn-shaped nest, tears its breast with its beak (see Plate VIII). Three dotted red lines lead from the wound to the outstretched mouths of three eel-shaped young birds uplifting their bodies from the nest. Colors, red, yellow, green and black. No writing. In possession of Henry K. Gross, of Plumsteadville. Date, about 1830.

3. Leaflet, 7⅞ inches long by 6¼ inches broad. No writing. Two tulips with other flowers sprout from heavy red stalks. Illuminated borders. Colors, red, yellow, brown, green, blue and black. Date, 1820. Made by Isaac Gross, died 1895. In possession of Henry K. Gross, of Plumsteadville.

4. Small leaflet, 4 inches long by 2 inches wide. Stalk bearing large tulip. Flower rises from centre of the heart. Name, Susanna Fretzin. Illuminated border. Colors, red, green, yellow, brown and black. Date probably about 1810. Property of Henry W. Gross, of Doylestown.

5. Unfinished leaflet, 7 inches long by 4⅝ inches wide. Words, *Diese Bibel ist gekauft worden im Jahr unsers Herrn 1830, den 25th December und gehoret mier, Isaac Gross, $10.* Abundant leafage springing from a heart with flowers and tulips done in red outline. Brush work just begun. Ornamental borderings. Colors, blue, black, yellow, red and olive. In possession of Henry K. Gross, Plumsteadville.

6. Leaflet, about 9 inches long by 6½ inches broad, with angels and illuminated writing done by teacher of Pebble Hill German School about 1800. In possession of Mrs. Levi Garner, Doylestown.

E. Taufscheine or Baptismal Certificates with Marriage and Death Registers in Bibles.

The German custom of preserving baptismal certificates, though wanting the force of legal compulsion, after crossing the Atlantic, survived until recent years in parts of Pennsylvanian Germany. Not practiced by the Mennonites, owing to their rejection of the doctrine of infant baptism, it prevailed extensively among Lutherans in northern Bucks and Lehigh counties, where however since about 1840 printed *Taufscheine*, gaudily colored, took the place of the old documents illuminated by hand.

Three of the printed certificates (giving the date of the individual's birth on a colored sheet adorned with hearts, wreaths, four birds, and angels blowing cornets, published by Johann Ritter, Reading, 1845, and in Allentown in 1848) were seen by the writer in October, 1897, in possession of Philip Flores, of Dillingersville, Lehigh county.

Examples of the old illuminated *Taufscheine* are:

1. Round leaflet, 7¼ inches in diameter, surrounded by a round band, spotted in red, the latter fringed on both sides with yellow and red scrolls. Text, in black, *Anna Maria ist von christliche Lutherische Eltern im Jahr Unsers*

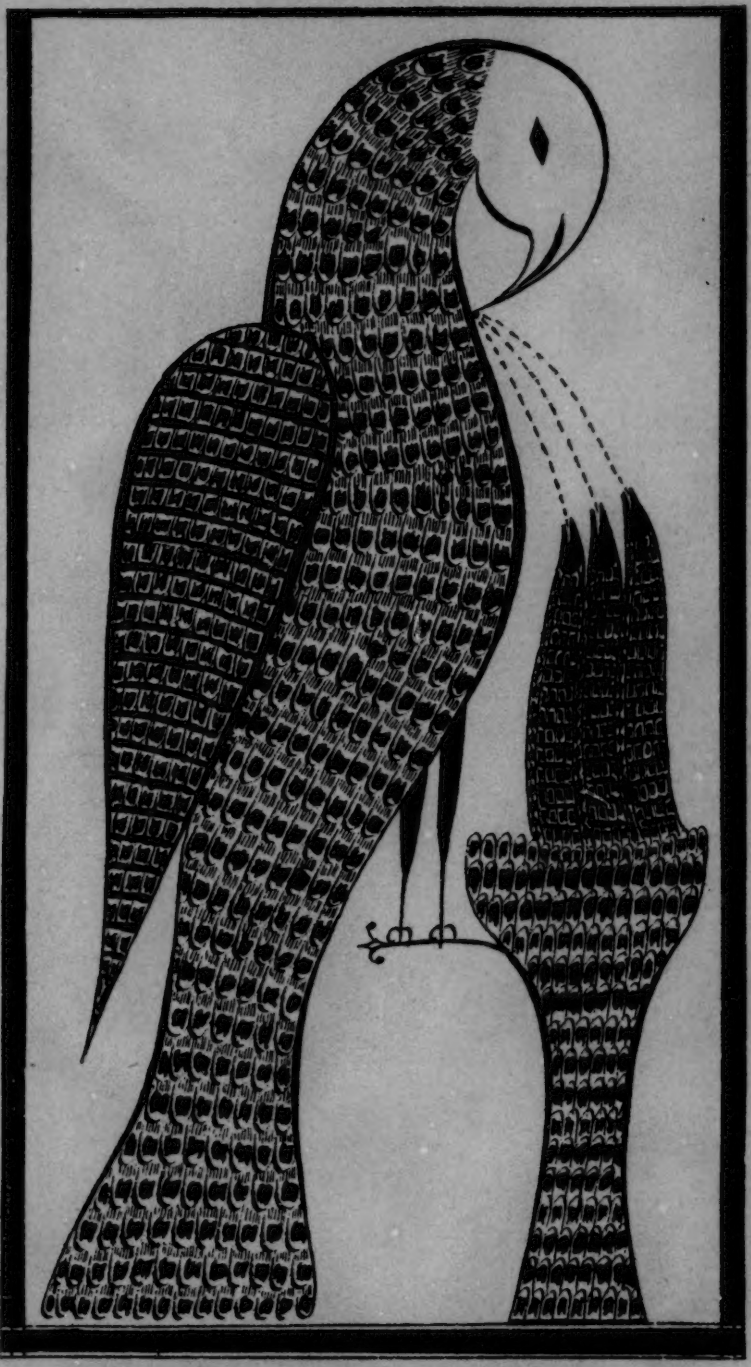


PLATE VIII.—The Pelican feeding its young with its blood. Sacred symbolic design in possession of Henry K. Gross, of Plumsteadville.

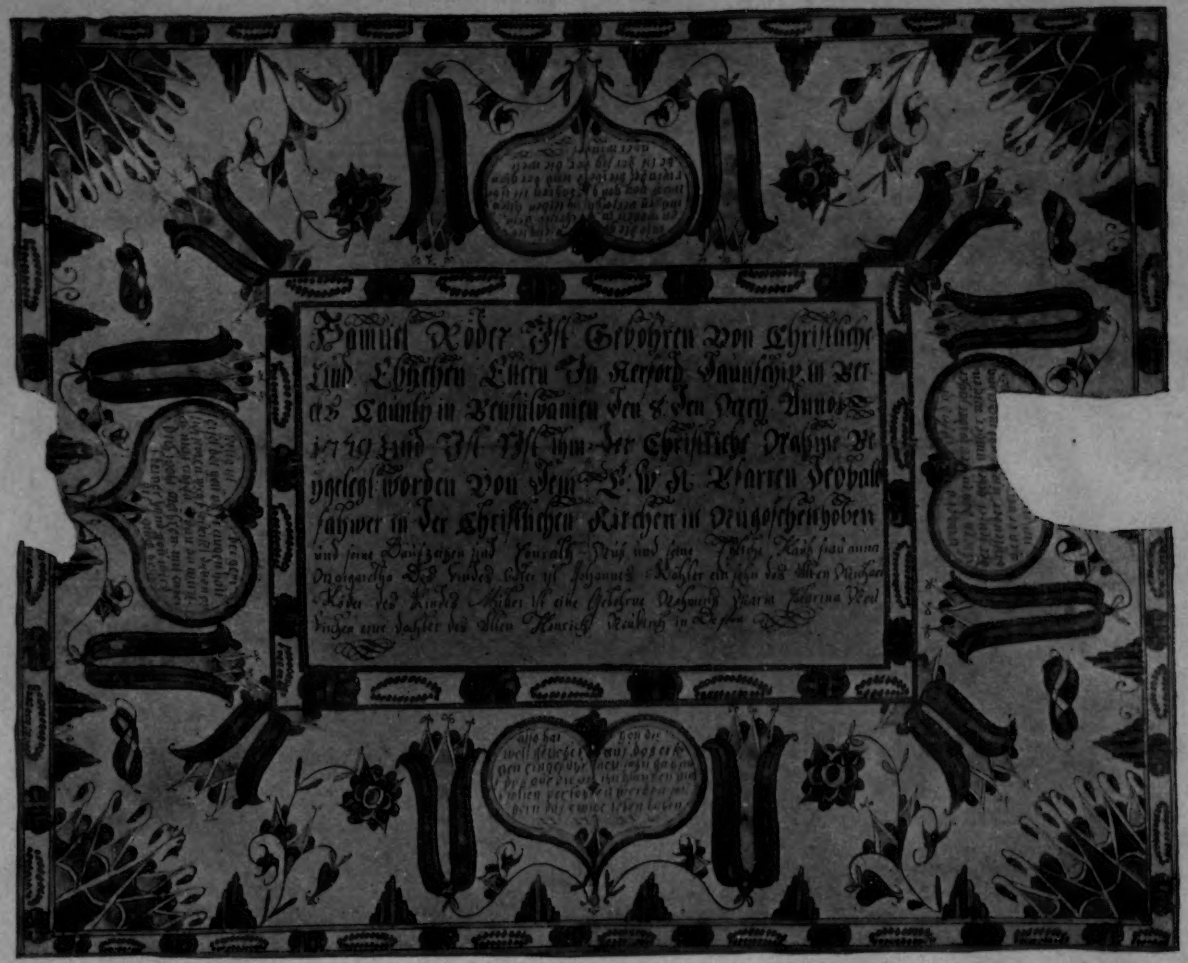


PLATE IX (about two-fifths).—Samuel Roeder's Taufscheine, 1779, showing the Heart and Tulip decoration. In possession of the Bucks County Historical Society. Courtesy of Nathan C. Roeder, of Shinnerstown, Bucks County, Pennsylvania.

Herrn Jesu Christi 1782 den 30. Jenner in Grossschwam Taunschip, Bocks Counti, Geboren, etc., giving name of minister, father, mother and witnesses. Presented by Mr. S. W. Boyer, of Spinnerstown, to the Bucks County Historical Society.

2. Leaflet, 15 inches long by 12½ broad. Text in scalloped circle inscribed with legend, *Wer da glaubt und getauft wird, der wird selig werden. Wer ihn nicht glaubt der wird verdamet werden.* The border is adorned with two large flower stalks, a singing bird and a swan, and two gaudy flying female figures with puffed hair and rosy cheeks, bearing flowers. Another singing bird adorns a small circlet, and upon a heart is inscribed the motto, *Dis Herz mein soll dir allein O lieber Jesu sein.* The baptismal inscription is in plain black Gothic text, *Diese beide Ehegatten als Johannes Erdman und Seine Ehefrau Sara, Eine Geborene Pitzin, Lutherische Religion, ist Einen Sohn Zur Welt Geboren als Heinrich, ist Geboren im Jahr Unseres Herrn Jesu Christi 1792 d. 29. Jany um 6 Uhr Abends in Saccon Taunschip Northhampton Counti im Staat Pensylvanien*, giving name of pastor and of witnesses. Colors red, brown, green and yellow. In possession of the Bucks County Historical Society. Given by Oliver H. Erdman, Steinsburg, Bucks county, Pennsylvania.

3 and 4. Two leaflets in style like the above. Certificates of Peter Floers, 1792, and Elizabeth Wetzel, 1804. Flying woman, birds, swans and hearts, floridly executed as above. On one of the hearts is the legend, *Dis Herz mein soll dir allein O lieber Jesu sein.* In possession of Philip Flores, Dillingersville.

5. Leaflet about 15 inches long by 12 wide, containing text in an ornamented square, with heavy border adorned with conventional flowers and tulips, and four hearts containing legends (see Plate IX). Colors brown, red, yellow, green and blue. A certificate in black German Gothic text, translated, says that "Samuel Roeder was born of Christian and married parents in Herford township, Berks county, in Pennsylvania, on May 8, in the year 1779, and was given his Christian name by the minister, Theobold Sahwer, in the Christian Church in Nugoschenhoben," giving witnesses, etc. Deposited in the Museum of the Bucks County Historical Society by Nathan Roeder, of Spinnerstown, Bucks county, Pennsylvania.

The marriage and death registers in Bibles are plainly executed as compared with the other specimens, and it seems that the practice of engrossing these latter lasted much later than the other phases of the art, and still continues (1897) among German families in upper Bucks county. More than two colors, red or purple and black, are rarely used. The elaborate scrolling, the leaves, hearts, birds and tulips, have disappeared. Examples are:

1. Register bound in Lutheran Bible of Mrs. Levi Garner, of Doylestown.

2. Similar register, in purple ink, made about 1890, in Bible of Mr. Elmer E. Funk, of Doylestown.

3. Loose register from Bible of the Hendricks' family near Perkasie, showing late survival of the tulip design. Words, *Sarah Hendricks ist geboren den iten September im Jahr 1851.* Capitals decorated in inferior style with leaves and

PLATE IX (about two-fifths).—Samuel Roeder's Taufscheine, 1779, showing the Heart and Tulip decoration. In possession of the Bucks County Historical Society. [illegible]than C. Roeder, of Shinnerstown, Bucks County, Pennsylvania.

three tulips. Colors, very little red, blue and yellow. Probably made in Bedminster. In possession of J. Freeman Hendricks, Doylestown.

It appeared upon inquiry that the art of *Fractur* was easily traceable to Germany, where, according to information received from foreign-born citizens of the United States living in Philadelphia and Bucks county, it had been taught without religious significance (generally in black, rarely in colors, save to special scholars, and sometimes, if desired, in Nassau with the reed pen of the monks), until about the year 1850, at public schools in Saxony, Bavaria, Hanover, Hesse and Nassau.

If the existence of Fractur in Pennsylvania had been adequately noticed before, its evidences are so interesting that it might well be described again, but we learn that it has been little more than casually alluded to by any writer. Yet it illustrates the relation of Germany to the United States at one of its most interesting points. It recalls the fact that while the English reformation was hostile to artistic impulses, the German reformers were not always unfriendly to them. In this case, at least, they held fast to one of the most beautiful products of mediæval fancy. Here is a contribution to American character at the beginning, for which we owe nothing to New England and the Puritans. Fractur did not come over in the *Mayflower*, nor did it flourish among the associates of those New England reformers who, at the siege of Louisburg, are said to have attacked the adornments of the captured cathedral with axes. As in the case of the Pennsylvanian earthenware of the last century, glazed in several colors and decorated with tulips or the lotus; as with the Durham stove plates of 1750, adorned by Germans with flaming hearts, tulips and designs of Adam and Eve, Potiphar's wife, and the Dance of Death, we see that we are dealing with a reflection of the artistic instinct of the Middle Ages, directed upon us from the valley of the Rhine. The fresher from Germany the better the work. But by degrees the iron caster forgets his trans-Atlantic inheritance of taste. A lack of skill finally overtakes the potter after years spent under sterner and more material conditions. First, the German mottoes are abandoned upon the plate and jar. By degrees the colors grow less varied and the designs weaker. Then the toys and whistles in the shape of birds, fish and animals, are forgotten with recipes for glaze. At last only the yellow tints of the pie-dish remain. So, too, the hand of the master

of Fractur looses its cunning and the fading art ceases to exist in the memory of a generation yet living.

The establishment of the English school system in Bucks county in 1854[1] necessarily resulted in the suppression of the previously existing German schools. Hence that date after which the latter, sustained by private subscription, lingered on for a time, reasonably marks the end of Fractur in a region where at least two aged masters of the craft still survive in the person of Jacob Gross, of New Britain, and John H. Detweiler, of Perkasie.

A study of these fugitive examples of a venerated handwriting leads the investigator by sure steps from the Germany of Pennsylvania to the valley of the Rhine, from the backwoods schoolhouse to the mediæval cloister. In the fading leaflets we recognize prototypes of the glowing hand-made volumes that illuminated learning in the Middle Ages and still glorify the libraries of the Old World. From the paint-box of Bedminster to the priceless book which at Venice is shown to the delighted visitor as the handiwork of Hans Memling, we are led by a chain of intimately related facts. With strange sensations, we rescue from the Pennsylvanian garret evidence indisputable of the passing away in the New World of one of the fairest arts of the cloister, which, meeting its death-blow at the invention of printing, crossed the Atlantic to linger among the pious descendants of the German reformers until recent years.

Stated Meeting, October 1, 1897.

Mr. INGHAM in the Chair.

Present, 11 members.

Donations to the Library and Cabinet were reported, and thanks were ordered for them.

[1] A German school sustained by a private subscription was taught by the Mennonite Samuel Musselman, in Swartley's schoolhouse, at the lower end of Hilltown, Bucks county, Pa., about 1866. Information of Mr. J. F. Hendricks Doylestown. Another, the last in Bucks county, existed, under the tuition of Mr. Meyers, of Deep Run, at the old Mennonite Schoolhouse near the meeting house at Deep Run, Bucks county, Pa., in the winters of 1895–96 and 1896–97. At the latter school where a pair of the time-honored leathern spectacles (*Bocksbrille* or *Schulbrille*) now in possession of the Bucks County Historical Society, were used to punish children in 1897, the ceiling rafters are still inscribed with bars of music written in chalk.

The Committee on Mr. Van Denburgh's paper recommended its publication in the *Transactions*, and it was so ordered.

The meeting was adjourned by the presiding officer.

Special Meeting, October 11, 1897.

Vice-President PEPPER in the Chair.

Present, 41 members.

The special meeting was called by the President for the reception of communications on subjects of science.

Lord Kelvin was presented to the Chair, and took his seat in the Society.

Communications were made by Prof. Heilprin on "The Absence of Glacial Action in Northern Africa."

By Prof. G. F. Barker, on "The Constitution of Matter."

By Prof. Doolittle, on "Latitude Variation."

By Dr. Kennelly, on "A Speculation upon the Nature of Cathode Rays."

By Dr. D. G. Brinton, on "The Measurement of Thought as Function."

The meeting was adjourned by the Chair.

THE VARIATION OF TERRESTRIAL LATITUDE.

BY C. L. DOOLITTLE.

(*Read October 11, 1897.*)

As the distinguished scientist with whose presence we are favored this evening has on various public occasions shown a deep interest in the problem of latitude variation, it has occurred to me that a brief communication on this subject might not be out of place on

this occasion. In this connection I shall speak of the work which we are doing at our newly erected Observatory of the University of Pennsylvania. As the audience is not composed exclusively of professional astronomers, it will perhaps be as well to give a brief statement in explanation of the problem.

The idea of possible variations in the latitude of points on the earth's surface is by no means a new one. It is, in fact, as old as Ptolemy. At various times, from that day to this, apparent changes of this character have renewed the interest of scientific men in this subject. It is probably superfluous to say that these supposed changes of latitude were almost exclusively due to imperfect methods of observation and to want of knowledge of various theoretical matters now well understood, that with improvements in instruments, with more perfect knowledge of the effect of refraction, with the discovery of aberration and nutation these supposed changes for the most part disappeared.

More than a hundred years ago, the illustrious Euler gave to this subject something like a scientific basis. In the development of the law of rotation of a rigid body, for which we are indebted to him, it was shown that a body like the earth, supposed to be perfectly rigid and in form an ellipsoid of revolution, unless originally started in its diurnal rotation about an axis exactly coinciding with the axis of figure, would have in addition to this diurnal rotation another motion. Suppose the original axis of rotation to make a small angle with the axis of figure. It was shown that this axis of rotation would itself revolve about the axis of figure, describing the surface of a cone, the angle between the two axes remaining unchanged. The period of this rotation depends upon the principal moments of inertia of the earth or upon their relation to each other, which may be found from the observed values of the constants of precession and nutation. The resulting period proves to be about 305 days, or ten months.

If, therefore, this period has a real existence, that is, if the axes of rotation and figure do not exactly coincide, it will, according to this theory, be shown by a periodic increase and diminution of all terrestrial latitudes in a corresponding period. Such a change was not found, though sought for by many investigators. In fact, the apparent perfection of the theory probably retarded the true development of the matter for several years. However, about ten or fifteen years ago, a number of apparent changes of latitude, found

from various series of observations made at different places and by different methods, began to awaken a widespread interest in the subject. That the changes were real admitted of but little doubt. It was equally obvious that they could not be fitted into the ten-month period of Euler.

Finally, Mr. Seth C. Chandler, by a most laborious investigation, embracing an analysis of many thousands of observations, extending over a hundred and fifty years, succeeded in solving the mystery, at least in so far as existing evidence can solve it. The result shows that the earth's axis of rotation moves about the axis of figure not in one simple period of ten months, but in two periods of twelve and fourteen months respectively, with perhaps a third of several years. The combination of these motions results in a somewhat complicated curve. If we suppose circles drawn about the north and south poles of the earth having diameters of about fifty feet, the extremities of the axis of rotation will always be found within these circles.

For the purpose of perfecting our knowledge of these motions, for obtaining data for a correct explanation of the same from a theoretical standpoint, very accurate and carefully executed series of latitude observations at different points are necessary. It is such a series we have undertaken at the Flower Observatory. This series is a continuation as far as may be of that which was kept up for several years at South Bethlehem.

In this work the instrument employed is the Zenith Telescope. The stars observed are arranged in groups so selected that the errors in the positions of the stars are almost completely eliminated in so far as they effect the apparent change of latitude. Regular observation at our Observatory for this purpose was begun October 1, 1896. Since this date observations have been made on nearly every favorable night. Two series constitute a complete night's work, the first in the early evening soon after dark, the second in the morning before sunrise. Each series embraces ten pairs of stars, requiring about two hours of actual observation. As will be seen, the work is laborious. This with the necessary numerical computation might very well be regarded as sufficient employment for one person.

Some 1700 observations, extending from 1896, October 1, to 1897, August 26, have been reduced so that we can form some judgment of the results obtained and of the character of the work.

We find a pretty satisfactory agreement with the theoretical results as given by Chandler's formula, the range of variation being about 0″.4, as indicated both by observation and theory. The phase, however, is a little more discordant, that is the times of maxima and minima, as shown by observation, do not quite agree with those indicated by theory. However, the amount of material is not yet sufficiently great to warrant any sweeping conclusions.

As to the quality of the work, the probable error of a single observed latitude is found to be 0″.14. This is derived from the mean of everything, whether the conditions were favorable or otherwise. It does not take into account the errors of the star places used, but is simply what is sometimes called the internal probable error.

The probable error of the mean of one series of ten observations will be something over ″.04. Nevertheless we find in comparing the results from consecutive evenings ranges sometimes as great as 0″.5, or say twelve times the probable error. Such variations from evening to evening are not peculiar to our own work, but are found in every extensive series which I have examined. In some cases the range has been found as great as 0″.7. The cause of these discrepancies is at present very much of a mystery. They are presumably due in great part to atmospheric causes, producing anomalous refraction phenomena. It is apparently a very difficult matter to deal with, but unless means can be found for doing so it would appear that we have about reached the limit of accuracy attainable in this class of work.

The instances before mentioned are the extreme ones. The fluctuations from night to night are usually far within the amounts mentioned. Usually it will be difficult to determine whether the variation is a real one or simply represents the error of observation. An unusually favorable opportunity for investigating this matter was furnished by the work of Marcuse, of Berlin, and Preston, of the U. S. Coast Survey, who, in 1891–92, carried on similar series of observations at Waikiki, in observatories separated by only a few feet. A comparison of the results with reference to this point was made by Marcuse, but the result was not very decisive. In a general way the number of cases of agreement in the direction of the variation was about twice as great as that of disagreement. One case in particular was very interesting, where for nine consecutive days the latitudes given by the two different observers always

varied alike. In other cases, however, for many consecutive days no agreement between the two series is apparent. It is greatly to be desired that this matter should receive a thorough investigation, but the method by which the problem may be successfully attacked is not obvious.

THE MEASUREMENT OF THOUGHT AS FUNCTION.

BY DANIEL G. BRINTON, M.D.

(*Read October 11, 1897.*)

I can best introduce what I have to say by a quotation from the address of Vice-President McGee before the late meeting of the American Association at Detroit. He refers in it to a distinguished member of our own Society who, I am glad to see, is with us to-night; and the words I am about to quote are of such a tenor that that they cannot be otherwise than agreeable. Mr. McGee said:

"Less than a quarter of a century ago Barker was deemed bold unto recklessness for undertaking to correlate vital and physical forces, and many heads were shaken doubtfully when, in his presidential address before the American Association at Boston in 1880, the same brilliant experimentalist argued from the application of Mosso's plethysmograph that mental force also may be weighed and measured, so that it must be regarded as interconvertible with other forms of energy; yet less than half a generation of organic chemistry has established these revolutionary propositions beyond peradventure" (*The Science of Humanity*, by W. J. McGee, Vice-Pres., Address before Section H, at Detroit, 1897).

These words must have been intended by their writer to have important limitations. If taken in their ordinary sense they would convey a very erroneous idea of the achievements of physical and chemical science.

It is quite true that the action of thinking is in one sense a function of the brain, and is accompanied by cell destruction, by increased temperature and by the increased elimination of inorganic matter through the secretory organs. For this reason it was said by one of the older physiologists that "without phosphorus there is no thought." In a somewhat similar manner others have undertaken to demonstrate that thought is merely a mechanical process,

and, indeed, a logical machine was invented by Jevons which could carry out a proposition from major premise to conclusion. From another aspect the late Dr. Post, of Bremen, used to maintain that "we do not think, but thinking goes on within us;" just like any other involuntary function of our bodies.

All such statements must be understood to apply only to certain concomitant phenomena of thought; but by no proper use of words can such phenomena be taken as the measure of thought itself. This measure eludes all chemical and physical research, and can in no way be calculated by mechanical formulas. The worth of the thought bears no relation whatever to the physical changes of temperature and cell activity concerned in its production. Mental force cannot be weighed and measured, nor is it convertible by any means known to us into other forms of energy.

The value of thought and the measure of mental force is, as has already been intimated by our distinguished guest this evening, the *truth* of the thought, the verity of the proposition. To quote from Shakespeare, "A tale told by an idiot, full of sound and fury, signifying nothing," may cost that poor idiot's brain just as much cell-destruction and increased temperature as did the composition of *Macbeth* to the great dramatist. A false or a worthless thought involves just as many changes as a true and valuable one. The brain of the savage is often as active, functionally, as that of the devotee to science; but how different the value of the results! As a physical stimulus affecting the lives of organic beings, the truth of thought is the only measure of the power of thought.

A striking confirmation of the views I am urging is the undoubted fact that the greatest conquests of thought, its most valuable productions, arise when the functional activity of the brain is at a low ebb. They are the fruits of what is called "unconscious cerebration;" or by its more modern name, "subliminal consciousness." The greatest inventions, the solutions of the most difficult problems in mathematics, the most marvelous inspirations of genius in art, have reached their finders in such passive moments. How wide of the mark, therefore, is it to expect to measure mind by units of matter! There is absolutely no common measure between them, and nothing in modern chemical or physical science weakens this ancient doctrine.

If what I have said is true as respects the facts of science, how much less capable are material weights and measures of appraising

those spiritual forces, whose potency lies in exalting the character of the individual, and in elevating the tone of national life, and on which alone we must depend for the real progress of the human race?

Let me, in conclusion, present this last point in the words of one of the noblest and most gifted women of our English-speaking race—Elizabeth Barrett Browning:

> "If we tread the deeps of ocean, if we strike the stars in rising,
> If we wrap the globe intensely in one hot electric breath—
> 'Tis but power within our tether—no new spirit-power comprising,
> And we are not greater men in life, nor bolder men in death."

Stated Meeting, October 15, 1897.

President FRALEY in the Chair.

Present, 41 members.

Mr. Stewart Culin, a newly elected member, was presented to the Chair, and took his seat in the Society.

Donations to the Library were reported, and thanks were ordered for them.

The death was announced of Prof. Alfred L. O. Cloiseaux, of Paris, France, a member of the Society.

Mr. Rosengarten was appointed to prepare the obituary notice of Mr. J. Sergeant Price.

Nominations Nos. 1380, 1389 to 1398, 1400, 1402 to 1409, 1418, 1423 to 1431 were read and spoken to, and Tellers were appointed to conduct the election for members, who reported the following as having been elected members:

2323. Clarence B. Moore, Philadelphia.

2324. James Biddle Leonard, Philadelphia.

2325. George Vaux, Jr., Philadelphia.

2326. James Seguin DeBenneville, Philadelphia.

2327. Richard H. Sanders, Philadelphia.

2328. William Tatham, Philadelphia.

2329. Gregory B. Keen, Philadelphia, Librarian of the University of Pennsylvania.

2330. George Wallace Melville, Washington, Commodore and Chief Engineer U. S. N.

2331. Charles D. Walcott, Washington, Director of the U. S. Geological Survey.

2332. Edward R. Squibb, M.D., Brooklyn.

2333. George Wharton Pepper, Philadelphia.

2334. Hon. Wayne MacVeagh, Philadelphia.

2335. John C. Smock, Trenton, State Geologist of New Jersey.

2336. Hon. Grover Cleveland, Princeton.

2337. Hon. Thomas F. Bayard, Wilmington, Del.

2338. William Libbey, Princeton, Professor of Physical Geography, Princeton University.

2339. Alfred T. Mahan, Captain U. S. Navy.

2340. Frank Morley, Haverford, Professor of Pure Mathematics, Haverford College, Pa.

2341. Woodrow Wilson, Princeton, Professor of Jurisprudence, Princeton University.

2342. George A. Piersol, M.D., Philadelphia, Professor of Anatomy, University of Pennsylvania.

2343. Lightner Witmer, Ph.D., Philadelphia, Assistant Professor of Experimental Psychology, University of Pennsylvania.

2344. Rudolfo Lanciani, Rome.

2345. James Mark Baldwin, Ph.D., Princeton, Professor of Psychology, Princeton University.

2346. Henry M. Howe, New York.

2347. Edward H. Williams, Bethlehem.

2348. H. Morse Stephens, Ithaca, Professor of Modern History, Cornell University.

2349. Charles R. Hildeburn, Philadelphia.

2350. Percival Lowell, Boston, Director of the Lowell Observatory, Flagstaff, Ariz.

2351. A. Donaldson Smith, M.D., Philadelphia.

The rough minutes were read, and the Society was adjourned by the presiding officer.

Special Meeting, October 29, 1897.

President FRALEY in the Chair.

Present, 100 members.

The special meeting was held for the reception of communications on subjects of science.

Dr. Fridtjof Nansen, a recently elected member, was presented to the Chair, and took his seat.

Dr. Nansen presented a communication on "Some Results of the Norwegian Polar Expedition, 1893–96," which was discussed by Commodore Melville, Prof. Abbè, Prof. Heilprin and Mr. Amos Bonsall.

The reading of the rough minutes was dispensed with, and the Society was adjourned by the President.

SOME RESULTS OF THE NORWEGIAN POLAR EXPEDITION, 1893–96.

BY DR. FRIDTJOF NANSEN.

(*Read October 29, 1897.*)

Mr. President, Ladies and Gentlemen :—

First of all, I beg to thank you most heartily for the great honor the Society has shown me and the cordial welcome you have given me.

It is with some hesitation that I come to discuss the results of the exploration from which I returned last year. The material I brought back is not by far worked out, and it will take years before it can be properly studied, and before this is done perhaps I ought not to talk much about the results for fear of giving you wrong ideas. But in the meantime I would like to point out a few of the more important points in our discovery, and I propose to begin with the geographical discoveries.

The whole plan of the expedition was based on a theory concerning the currents, about which we knew very little before. I thought, for various reasons, that there was a constant drift of

the ice across the north polar region. I would especially refer here to some relics from the American ship Jeannette, which were found on the southwest coast of Greenland three years after the Jeannette was crushed and sank at a point northeast of the Siberian Islands. The question arose, How could these relics have come to the coast of Greenland? The only feasible explanation, in my opinion, was that first proposed by Prof. Mohn. The relics must have been drifted straight across the polar region to the north of Franz-Josef Land and Spitzbergen, then must have come southward by the east coast of Greenland, thence around Cape Farewell and northward along the southwest coast. (Dr. Nansen then taking his position by a chart pointed out the supposed course of the relics.) Here is a map of the polar region. The Jeannette was beset in the ice near the Wrangel Island, which was then believed to be a large land, extending northward. She was drifting for nearly two years in a northwesterly direction to a point about here (indicating), where she was crushed by the ice pressure and sunk; and, as you know, the gallant crew of that vessel had a desperate struggle to reach inhabited parts, and it is unnecessary here to touch upon the sad fate of most of them.

Three years later some relics were found down here (pointing to the southwest coast of Greenland) and the only explanation was that they must have drifted this way down (indicating). There was, however, other evidence that made me believe still more firmly in this constant drift across, and that was especially that drift timber is found on the Greenland coast, on the Spitzbergen coast and on various other lands in the Arctic regions, and that most of this drift timber proves, on examination, to have come from Siberia. The only explanation, in my opinion, is that this drift timber must have been carried to these shores by the floe-ice across the polar sea somewhere near the pole; although I must say that this opinion is against that of most authorities.

As a further proof I will mention a third evidence of great importance, and that was some mud that I found on the ice floes on the east coast of Greenland. This map does not show it, but Iceland would be about here (indicating) and there is a strait between Iceland and Greenland. In this strait I collected, in 1888, some specimens of mud, and by a microscopic examination of this mud it was found to contain many diatoms never found anywhere else in the world except near Bering's Strait. Some specimens collected

by the Swedish Vega expedition were examined by Prof. Cleve, who also examined my mud. He said "that the diatoms contained in the two samples of mud are perfectly alike, and are totally different from those contained in all other samples in the whole world." I thought it could not be explained in any other way but that there must be some connection between the two places, the ice carrying the mud to where this mud was found across the polar sea.

There were also other evidences that made me believe in this drift current. If this drift really existed, I thought it a simple thing to go with it; to build a ship strong enough to stand the pressure, push her into the ice and let her be carried along with it just as the Jeannette was. And that is what the expedition accomplished. As the expedition was therefore undertaken with the intention to drift with the ice, we could not expect that we would discover many new lands. My hope was to keep clear of the land, as that would stop our drifting and perhaps oblige us to leave the ship and travel over the ice. We were fortunate enough not to meet any land. We found only one vast extended sea in the north, which was very much deeper than we had expected.

Before we set out a good many authorities said that the reason why such a drift was impossible was because we would meet with much land in the north, and that the sea was shallow. So far as we knew it was shallow north of Asia. The greatest depth found by the Jeannette expedition was eighty fathoms. I also believed that this sea might be pretty shallow, but seeing that there was a deep sea north between Greenland and Spitzbergen, a sea extending up to 2600 fathoms in depth, the northern limits of which had not been found, and seeing at the same time that the depth increased with the progress of the Jeannette expedition, as it was carried to the north and east, I said it looks as though there should be some connection between the deepening of the sea to the north of where the Jeannette expedition met with disaster and this deep sea east of Greenland. I thought there might be some narrow channel or trough of deep sea across the polar region.

Great was my astonishment when I found a great depth as soon as we got north of the New Siberian Islands. All the way north from the Siberian coast there was a very shallow sea, only twenty or thirty fathoms deep, until at a certain point the depth suddenly increased and we could not reach the bottom with all the lines we had on board. We had to make new line and at last we found the bottom.

at about 2000 fathoms, and we found the same deep basin along the whole route of the Fram across the polar region.

The question then arises, Of what extent is this sea? I did not find anywhere any indication that the sea grows shallow. We see it stretching from the south northward into the unknown. We also see it stretching eastward to the region north of the New Siberian Islands and we might expect it to extend much further eastward. When we look at the deep seas on the rest of the globe's surface we do not find anywhere such a long, narrow extension of very deep seas; and, therefore, the probability is that this sea is much broader than we had an opportunity of ascertaining. We may therefore say that we have established the fact that a great part of the polar region is an extended, deep sea, instead of the shallow sea that we believed in before. I think there cannot be much doubt that the whole of the polar region lying on the Asiatic and European side of the pole is one extended sea.

For this belief we have several reasons. First, as I have just mentioned, the depth of the polar sea indicates some extension of the sea to the north of the Fram's course. But there are other evidences. It is evident that ice drifting in a sea where there is land in the neighborhood will be stopped in its drift as soon as it drifts in the direction of this land. Now, however, if there had been land anywhere in the neighborhood of our route it is evident that if the ice happened to drift in that direction it would have been stopped at once. But we never saw anything of the kind. The ice seemed to drift readily in almost every direction as the wind commenced to blow in that direction. The only direction in which the ice seemed to drift slowly and with some difficulty was backward in the direction from which we had come, and there we knew there was nothing but open sea. Very easily, say as soon as the southerly wind began to blow, the ice drifted toward the north, consequently there was no possibility of land being found anywhere near us in that direction.

There is another evidence which is even stronger, and that is the amount of floe-ice or polar ice floating southward through the channel between Spitzbergen and Greenland and especially along the eastern coast of Greenland.

When you look at the route of the Fram you see the drift going in this direction (indicating). She drifted to about this point (indicating), and then began to work herself out of the ice

by forcing herself forward with the help of her steam engine. If she had not done this she would, of course, have been drifted further in the same direction, and then she would as you see have been drifted southward along the east coast of Greenland, and might have drifted in that direction for a year more.

Thus you see there would have been a broad belt of drift ice drifting southward between the Fram and the coast itself. It is evident that this ice must have traveled by a route similar to that of the Fram, but that route had been to the north of the Fram's. All this ice (indicating) must therefore come from an extended sea lying to the north of our route, and consequently there cannot be any land in that region stopping the drift. Thus, we have good reason to believe that the whole extent of this region on the European and Asiatic side of the pole is nothing but sea, perhaps with some small islands of no importance. In my opinion the pole itself is situated in the same extended deep sea.

This distribution of the land and water on the European side is, I think, the most important feature of the geographical discoveries made by us on the expedition. There might, of course, be found land on the American side of the polar region. It is not probable that we should just now happen to have found the northern limit of land on this side. Much still remains to be done by future expeditions in geographical exploration.

Before leaving the subject of geographical discoveries, I will briefly mention the extent of Franz-Josef Land. You know that the group of islands situated to the east of Spitzbergen, called Franz-Josef Land, was discovered by the Austrian Tegethofft expedition in 1872–4. The expedition had only explored the southern coast of this land and made a dash northward through a narrow channel which was called Austria Sound. Afterward the English explorer Leigh-Smith came two summers to this land and discovered the more western part of its coast. The last time he came his ship was crushed and he spent the winter there and came back in boats the next year. The northern extension of this land was not at all known, and therefore it was believed by some authorities that this land was only the southern coast of a big continent extending poleward. I did not believe this; I believed that Franz-Josef Land was only a group of islands. Now with our discoveries and those of the English Jackson-Harmsworth expedition it is an established fact that Franz-Josef Land

is a group of very small islands. We came southward here (indicating) and we saw there was no land of importance to the north. The island we first met with was situated in 81° 38″ north latitude. We traveled along the north coast here (indicating), and now the English expedition has this spring traveled along the northwest coast of these islands here (indicating) and found that there was nothing but a comparatively small island which approximates the most western point of this map. Consequently we know pretty nearly the whole extent of Franz-Josef Land. We want to know its extent toward the east and it is hoped that some expedition not far in the future will settle that.

While I have mentioned the geographical results of the expedition, I should mention the geological results also, but will not detain you long with them. There is one important geological discovery which we made, and that is the evidence we found of a glacial epoch in Siberia. As you certainly know, the whole of northern Europe and the northern parts of North America have had at least one glacial age, during which they were covered with an extensive ice cover as Greenland is at the present time. It was, however, generally believed that Siberia and the whole of northern Asia had had no glacial age, as there were no marks indicating an ice-cover in those countries. During our voyage along the Siberian coast I had an opportunity of visiting the coast at several places, and everywhere I found signs that there had been at one time a glacial covering, an ice mantle over the whole country. We found the coast here pretty much cut up. It did not look as it appears on this map, but looked more like the western coast of Alaska, and more like the coast of Norway.

Outside of the coast there was a belt of islands which we find only along the coasts of lands which have once been covered with an ice cap. This is but an indication that something of the same kind must also once have existed in Siberia. But I found more certain proofs that such had been the case. In one place I saw the rock scratched with glacial striæ and marks, which is a certain evidence that glaciers have once covered that country. In another place I found ground moraines covered with big erratic blocks of various forms, and there is, in my opinion, no explanation of these blocks being there except that they have been carried by glaciers similar to what we know have been in Europe and America.

I have already mentioned some of the evidences on which I

founded my theory about the drift of ice across the polar region. I have mentioned that the expedition was accomplished in the way it was planned, and thus the theory was proved to be fairly correct. The expedition has, however, given us a great deal of information which enables us to form a much clearer and better idea of this drift of ice across the polar region than we could have had before. We have had plenty of experience, and have made many observations of how this ice is constantly being drifted from one side of this polar region to the other. What causes this drifting? The drift is for the most part caused by the prevailing winds. The data collected have not been calculated yet, but so far as I can now say the direction of the prevailing winds was pretty nearly the same as the prevailing drifts. Perhaps they do not, however, quite coincide, as I believe there are some other factors which also help to decide the final drift of the ice.

The prevailing winds in this region during the whole year go from this Siberian side (indicating) toward the Atlantic sea, and consequently sweep the whole expanse of ice cover out into the Atlantic sea. That is the main feature of this drift. Of course there are many variations, many periods of drift during the year. At some periods the drift is more rapid. At other times the drift stops, or even goes in the opposite direction. But as a rule the best period for the drift to go in the direction we wanted was the winter and spring, and the worst period, generally, was the late summer and autumn.

I may mention here that the route you see on this map[1] is very much simplified. If we had it marked down as it really was it would not be possible to understand it; it would be so complicated that you would not know one drift from another. During the first autumn we had a drift backward, and were drifted southeast into the shallow sea and toward the New Siberian Islands again. Then the winter came and we were pushed forward until the middle of June, and then came another bad period and we were pushed backward. Then it began to drift onward again until the next year; then there was a stop again during the summer. Then there was a more favorable drift during the winter again until the Fram worked her way out of the ice to the north of Spitzbergen.

You will understand that we are now able to form pretty nearly a complete picture of the motion of this ice in the polar sea. You

[1] An enlarged drawing of a map given in "Farthest North."

see how it is carried across the polar regions from the Siberian side toward the opening between Spitzbergen and Greenland, and also toward the channel between the islands in the North American archipelago. As, however, there is no such gap between these islands as between Spitzbergen and Greenland, the ice there seems to be very much blocked, and is stopped for years and gets very much thicker than on the East Greenland and Spitzbergen side. By snow being heaped upon it year after year it forms striæ similar to what we find in glacial ice; it is what has been called the paleocrystic ice by the English and American explorers.

You understand that our expedition has removed that extended massive and immovable ice-cap, or mantle, which so many explorers thought covered the polar region. Instead we have found a deep sea covered with a comparatively thin layer of ice in constant motion from one side to the other, being one link of the eternal circulation of the ocean.

We had a very good opportunity to study the formation of this ice. I shall mention here only the growth of it by the frost. A good many people, I dare say, believe that the ice in the north goes on growing forever, and that it gets thicker and thicker every year it remains there. That is, to some extent, the case; but it is not quite so simple, and the growth is not so quick as one would generally imagine. In the beginning, as long as the ice is thin, it grows very rapidly. It was measured at certain intervals during the whole expedition. Ice formed in November of the first year, 1893, had in April, 1894, attained a thickness of seven and a half feet. On June 9, it was eight feet three inches thick. That is about the growth of one year. In some parts it was nine feet thick. In the last month of summer and in the autumn it melted a little. At the beginning of the winter, in September, the same floe was about six and a half feet thick. Then the growth began again very slowly, and in May of the next summer, 1895, the same ice had become nine feet ten inches thick. You see it does not increase very much after the first year. The next year another floe was measured. At the beginning of the winter, in November, it was eleven feet thick. At the end of that winter, in May, 1896, it had reached a thickness of thirteen feet six inches. This ice was about three or four years old. The most of the ice that drifts across that region will not grow much thicker directly by freezing, as it is carried across the polar sea, at most, in five years.

By the pressures the ice is, however, piled up to very much greater thicknesses, and ridges and hummocks are formed, the height of which may amount to twenty feet or even more above the water. The highest hummock I ever measured was twenty-three feet high, so far as I remember. I saw a few which I estimated to be about thirty feet high. These hummocks will freeze solid and will last for years. I might mention one which was formed near the Fram in January of our first year, which followed the Fram during the whole time of the drift. This hummock has probably drifted on southward along the East Greenland coast. The ice floes are crushed easily, but these hummocks require much more force to crush them. They will stay together and be the last remnants of the ice to be carried around Cape Farewell and the west coast of Greenland.

The cause of these ice pressures has already been referred to in the accounts of previous expeditions. It is a fact, which has often been observed by various explorers, that the pressures are to some extent caused by the tidal currents. Our observations showed that at the margins, near the outer edge of the polar ice-pack, where there is an open sea to the south, the ice pressure is almost solely caused by the tidal currents. The pressures were there often so regular in their occurrence that we could say beforehand when the ice pressures would occur. We knew that they would come with the spring tide, the heaviest ones a little after new moon, and another period with less heavier pressures about full moon. The pressures would at these periods generally occur twice in twenty-four hours. Then the ship would often be lifted a good many feet out of the water, while in the intervals the openings in the ice would widen out and the ship would be floating in a broad, open channel.

In the interior of the polar ice these tidal currents do not seem to have much influence on the pressures. I could not discover any regularity in them there. The pressures seemed to be caused mostly by the changing winds. It is evident that when the wind suddenly changes, especially to the opposite direction to that from which it has been blowing for some time, immense pressures must arise. The great body of ice is moving on, while in front the ice is moving against it. We had a very severe nip on such an occasion about New Year's day, 1895. I dare say it was the heaviest ice pressure any ship has ever been exposed to, and that was

in the middle of winter when the ship was frozen fast in her ice berth.

These ice pressures which form the hummocks that I have spoken of, and which make the ice so much thicker in some places than in others, give room for cracks and open water lanes in which new ice is formed. Thus one must not think of the polar sea as being covered with one even layer of ice. We find floes of all thicknesses from this newly formed ice on the lanes up to the big hummocks which are very deep.

There is one important feature in our discoveries about which I shall say a few words, and that is the temperature of the sea. As is well known, the temperature of the deep sea all over the world is very low. It is not many degrees above the freezing point. In the northern part of the Atlantic ocean the bottom, and in fact the whole sea on the Greenland side, is filled with water two or three degrees below the freezing point. The temperature is about 29.4° Fahrenheit through nearly the entire depth from the surface down to the bottom. Of course as far as the Gulf stream runs north the surface is very much warmer. As the polar sea sends southward such a cold current, filling the whole depth of the North Atlantic, you would naturally expect the whole polar sea to be filled with such cold water. But such is not the case. We found that from 100 fathoms under the surface of the polar sea down to the bottom the water is warmer than we find it in the depth of the North Atlantic ocean. I will give you a few of the observed temperatures. The surface of the polar sea is covered with a layer of water of comparatively low salinity, and is very cold. But when you penetrate down through this layer you find that the temperature begins to rise. At the surface you find the temperature —1.5° Centigrade, which means 29.3° Fahrenheit. But at a depth of 110 fathoms you suddenly come on warm water, the temperature of which would be as much as 32.9° or even 33.4° Fahrenheit, which you see is very much warmer than you would expect or than you find in the deep sea in the North Atlantic ocean.

At a greater depth the temperature varied somewhat, but remained about the same to a depth of 220 to 270 fathoms, after which it sank slowly toward the depths, though without sinking to the cold temperature of surface water. Near the bottom it again rose quite slowly. These conditions were fairly uniform in that part of the sea over which we traveled and where investigations were made.

It may seem rather striking that the sea should be so warm in the depths and so cold on the surface. The reason is natural. I may say first that the cold surface layer of water was fresher than the lower warm layers. The deeper water had a high salinity very much like the Atlantic water. That is the reason why this warm water is heavier than the cold water and keeps below. All this salt and comparatively warm water runs into the polar sea from the Atlantic ocean, filling the whole depth of the polar basin, while its surface water to some extent is mixed up with the fresh water running in from the American and Siberian rivers.

The Atlantic water is slowly cooled down and is gradually, to some extent, mixed with the fresher water of the surface and is then again carried out into the Atlantic ocean as water with less salinity than the Atlantic water and much colder; and on that account is heavier and sinks and fills the bottom of the sea. What is the result of these conditions? The result is that the fresh water floating on the top of the salt warm water protects the ice to some extent from the influence of the heat which is carried into the polar sea by the Atlantic water. It allows that ice to grow slowly year after year. If this fresh water had not existed the Atlantic water would come to the surface in the polar sea, and this covering of ice would consequently be very much thinner.

If we look backward through the ages and ask what the result would have been if the geographical distribution of the land and water were a little different from what it is to-day, what result would we expect? What would the result be if we were to shut up the whole polar basin, not allowing this warm water to flow into it and not allowing the ice and the cold water to float out of this polar sea? If we had a bridge of land passing from Greenland to Iceland and across to the Faroe and Shetland Islands, uniting Scotland and England with Greenland, and consequently closing up the whole entrance to the polar sea, what would be the result?

The result would be that no warm water would be carried from the south to the polar region; the ice would be allowed to block up there year after year and would not be allowed to drift across and out, and by and by the whole polar sea would necessarily be covered with a very much thicker layer of ice and snow than at present. This layer would at last have no more motion and the thickness of the ice would allow the temperature to fall during the winter on account of the radiation of heat from the surface. This

would produce a cooling down of the polar region to a much greater extent than exists to-day.

Consequently we would have in the north a colder climate, and we would at the same time have a warmer climate in the south, because the ocean would not be cooled down by the northern ice, and it would be prevented from giving off a good deal of its heat to the polar region. That might to some extent explain a colder climate in the north and a warmer climate in the south, but I do not think it would be sufficient to explain the glacial periods. It gives us, however, some idea, or some factor that would explain the changes of climate on the surface of the globe.

You might ask what would be the result if we could open out the entrance to the polar sea and let more warm water flow into it. If, for instance, the Bering's Strait could be made much wider and deeper than at present, so that the warm Japanese current, the Kurosiwo, could run into the polar sea, its temperature would then, of course, be very much higher than at present. It would still be covered by a layer of fresher water from the rivers flowing out of Siberia and America, but the thickness of the ice would be less than at present. If we, however, could let the rivers of Siberia flow in some other direction, not going into the polar sea, but somewhere else, so that the polar sea would not be covered by such a layer of fresh and cold water, what would be the result? The warmer water would then come up to the surface, the ice would necessarily be thinner, we would get much more open sea in the north, and to some extent the climate would be milder. At the same time much more cold water would run out of the polar sea into the Pacific and Atlantic oceans, and would cool down the temperatures in those latitudes.

I do not think this explanation is sufficient to account for the much warmer climate in the north when we, for example, had a subtropical climate in Greenland and Spitzbergen. At the same time it may give you some idea of what such changes in the distribution of the land and water would result in.

I will not go further into these very difficult questions. I just mention this to show you what glimpses polar exploration might give us into the conditions existing during other ages of the earth. This is only one side of the many results which polar explorers have brought back from the polar regions. They have to a great extent enlarged the knowledge of humanity. They have made it possible

for us to form ideas of the past history of the globe which we would not have been able to form had not man gone out to explore these regions.

I hope to see new expeditions start soon again for these regions, and I trust that especially this great nation will take an important part in them. We know from what you have accomplished in the past that you will be able to achieve great results to the benefit of the nation and to the benefit of humanity.

COMMODORE GEORGE W. MELVILLE:

It is with a great deal of diffidence that I arise to speak at all in discussion of so clever a discourse as that of Dr. Nansen, much less to criticise it, for my experience in three different Arctic voyages, in different Arctic seas, has taught me that only those who are in the same field at about the same period can have the requisite information to undertake a critical discussion. Moreover, Dr. Nansen's experience with respect to ice conditions, its formation, drift and other phenomena, so fully agrees with my own in the Jeannette, that there is no room for argument.

However, my sojourn of twenty-two months in a drifting pack of no mean proportions, extending from the Pole south to 70°, emboldens me to speak of some experiences, second only to those of Dr. Nansen and of Weyprecht and Payer of the Tegethoff expedition of 1871 to 1874.

The Jeannette, Capt. De Long, U. S. N., was boldly pushed into the ice in latitude 71° 35′ N., 175° W., as we then believed the theory of Dr. Petermann, the celebrated German geographer, that Wrangel Island might be of continental proportions, extending to the northward and eastward toward the Pole, and possibly extending so far to the eastward as to overlap the northern part of Greenland. It was thought to be what some explorers had supposed to be land seen to the northward of the Spitzbergen, and extending as far to the eastward as the archipelago formed by the Spitzbergen on the west and Franz-Josef Land on the east.

It took us but a few days to prove that Wrangel Land was only an insignificant island, as we drifted across its northern face, at times in as little as thirteen fathoms of water; and at times as close as fifteen or twenty miles to its northern shores.

It is needless to state that drifting in a heaving pack in so shallow

a sea was most hazardous, the underrunning and overrunning of the floes causing them to telescope and rise to heights at times approaching 100 feet.

After our ship was solidly frozen in, she was never again released until she was finally crushed on June 12, 1881, after we had drifted twenty-two months in a zigzag course, many times lapping and crossing and recrossing our track. The resultant of our drift was north, 45° west true, distance 1300 miles, when our floe broke up, and the ship was crushed, in latitude 77° 15′ N., 155° E., leaving us 500 miles in a bee line from the nearest point of succor, the mouth of the Lena river, Siberia. We were left on the ice, thirty-three officers and men, with seven on the sick list, and with the disheartening prospect of hauling our baggage an indefinite distance to clear water. It consisted of eight pieces, giving each man fit for duty a load of 290 pounds to haul.

Just here, let me call attention to the very important fact that the Jeannette expedition is the first on record where such a long imprisonment in the Arctic pack was not accompanied by scurvy. The Lady Franklin Bay expedition, under the command of Lieut. (now General) A. W. Greeley, U. S. A., was the second up to the date of our wreck which had escaped the dread scourge. Our good fortune, so different from the experience of previous expéditions, can be clearly traced to good food, distilled water, good sanitary conditions, a light, though healthy diet, and abundant outdoor exercise, not of a laborious or wearying nature, every day in the year.

You will, I am sure, pardon me for introducing a few facts of the drift of the Jeannette, as leading up to the drift of the Fram, for Dr. Nansen put his ship into the ice to commence his drift about where the Jeannette let go, though a little farther to the westward. In other words, the Fram finished the drift that was commenced and prosecuted by the Jeannette involuntarily, for our intent was to go to the northward and eastward. But, after being beset in the pack, and drifting across the north face of Wrangel Land, we were pretty sure that there was no possible retracing of our course, unless, by a swirl or turn of the floe, we might be cast out on the coast of Siberia, as the whaleship Mount Wollaston and others had been, which were visited by the native Tschuckchees and found abandoned.

As the cartographer of our expedition, I was directed to make a circumpolar chart showing every known current that had been laid down by Arctic explorers, from the time of Barents and Wil-

loughby to date. We were fortunate in having a very extensive Arctic library on board, and, as the discussion of Arctic literature and the formulation of theories and conjectures were among our pleasantest ways of passing time, you can well imagine that, with eight intelligent readers in our cabin mess, it was not long before I had a chart with hundreds of arrows denoting currents as laid down by voyagers for more than 300 years. It was remarkable how plainly they pointed to the fact that, if our ship should hold together and our provisions last, we should drift out either by way of Franz-Josef Land and Nova Zembla, or, taking the northern cant across the north face of Franz-Josef Land, between the Spitzbergen and east coast of Greenland. That was as well understood and believed by the officers of our ship as it is to-day proved by Dr. Nansen.

In addition to what we learned from our drift chart, we also knew that drift wood covered the east side of the Spitzbergen, Franz-Joseph Land, and even the northeast coast of Nova Zembla, where grand old Barents wintered, and it was certain that this was brought by the great Siberian rivers discharging into the Arctic ocean. These facts had all been established before our time, but none of us then supposed for a moment, nor do I now believe, that this débris would drift across the North Pole. In fact, I have not believed hitherto that it ever drifted beyond 85°, but Dr. Nansen and the drift of the Fram have demonstrated that it has drifted north of 86°. So I must concede that latitude, at least, as possible for drift wood to reach.

There were, however, two great "ifs" in the way of our accomplishing this long drift: Could our ship hold together; would our provisions hold out? We had pumped our ship night and day for twenty-two months, at first by hand and steam power, afterward by a wind-mill that was extemporized on board ship, supplemented by hand power, or steam, as the emergency arose. The merry "chug" of the pump night and day, for twenty-two months, never ceased. Our game in the far north had become scarce, and we had not added much to our larder beyond a few seals, walrus and bears we had taken in the early part of our drift, in the spring of 1880.

After many consultations about the situation by the officers of the ship, and a close account of the provision list, it became manifest that our provisions would be exhausted before January, 1882. So, the question was whether we should abandon our ship in the spring

of 1881, or the fall of the same year. As seamen, loyal to our ship and duty, we decided to remain by the ship as long as possible, though sober judgment taught us that the proper time to abandon the ship was in the spring, which would give us mild weather and summer game to assist us on our retreat. At that time, we were nearly due north of the New Siberian Islands, which seemed like stepping stones toward the Lena river and the coast of Siberia.

The problem was solved for us by the breaking up of the floe, which, in time, crushed our ship; and, amidst the crashing and grinding of the poor old ribs of our good ship, we were cast out, Cæsar-like, from the bowels of our good mother Jeannette, who had sheltered us and kept us warm all these months.

At this very time we were making our most rapid drift to the northward and westward, and it was impressed upon us in a most startling and disheartening way. The Jeannette was crushed and sank in latitude 77° 15′ N., longitude 155° E.; after marching southward twenty-one days, we found ourselves in latitude 77° 36′ N., longitude 153° E., or actually *twenty-eight miles northwest of where we had started* and at the most northerly point of our voyage. This rapid drift is the key to the situation pointed out to our good friend, Dr. Nansen, who had the sagacity to seize the idea and to originate the theory that has led to his great success.

As I have said, our retreat lay directly south, about five hundred miles in a straight line. At the start we had sixty days' provisions, allowing one and a half pounds per man per day. Most of our dogs had died during the first winter, and of the remainder we shot all but eleven good ones, which, however, rendered very little service, eating nearly as much as a man and doing about one-tenth as much work, so that we finally shot them also.

Thus we journeyed, dragging our boats and provisions on sledges over the broken floe, and finally taking to the boats to cross the open sea to the Siberian coast. It was the stormy fall season of gales, ice and snow. Our small open boats were often in danger of foundering, and in the fiercest of the gales Lieut. Chipp's boat was swamped, drowning him and his seven men.

The other two boats, those of Captain De Long and myself, succeeded in reaching land, although one hundred and fifty miles apart, thus ending our long retreat of one hundred and ten days. De Long and all but two of his men perished of cold and starvation. My crew of eleven all told were more fortunate, all being saved,

although one died of smallpox in Siberia on the way home. The total loss was thus sixty-six per cent. of the personnel of the expedition, and of the original survivors there are only six now alive.

Now, as regards our drift. It was quite evident that, for the first eighteen months at least, our drift was caused by the fierce southeasterly gales that drove the pack up into the northwest. We can conceive the effect of the innumerable hummocks of ice, like millions of sails set to catch the breeze. After the subsidence of each gale, we took a rapid setback drift to the southeast. In fact, in the spring of 1880, after our first winter in the pack, we were driven back in sight of Wrangel Land to about the place where we were first beset, which accords with Dr. Nansen's experience.

Dr. Nansen found a deep sea to the northward and westward of the line of our drift, which is the exact opposite of our experience in the part of the ocean we traversed. Although soundings were taken every day at noon, they never but once showed more than from thirteen to thirty-six fathoms. Even this greatest depth was only eighty fathoms, which occurred at the most northern point of our drift during the winter of 1880.

I had a theory of an ice cap at the Pole (which, by the way, our good friend, Dr. Nansen, has very materially shaken) extending down to about 85°, against which I believed the drifting pack impinged. Between this supposed ice cap and the drifting pack, in the shallow sea in which we were drifting, I conceived a canal of comparatively deep water, which my messmates in derision called "Melville's Canal." It is needless to say, however, that I was pleased, as were also my messmates, to find that we were on the edge of "Melville's Canal" when we got a cast of the lead in eighty fathoms of water, and they conceded that my theory of a deep canal might be correct, so that, in our theories at least, "Melville's Canal" had a recognized standing.

Unfortunately, after the southeasterly gales had ceased to blow, we were rapidly drifted back again by the receding ice, and never again got far enough north to find the deep water where currents alone can run. It is impossible for any geographer to conceive of a natural sea current in a shallow sea of thirty fathoms. Local currents, it is true, may be caused by wind or tide, if there is any; or by the outflow of great rivers, but a natural current of inlet and outlet, caused by the heated or chilled waters, such as the mighty Gulf Stream, or the Kuro Siwo of Japan, can only run and be

maintained in water whose depth is measured in hundreds of fathoms. Such seas we did not find. Hence, my theory of wind currents in a shallow sea. Another fact of our drift is that our floe was continually swinging around, not always in the same direction, as our ship's head pointed to every point of the compass, though frozen solidly into the moving pack, demonstrating the fact that the great floe itself was in a "swirl." Dr. Nansen was more fortunate in early striking "Melville's Canal," where the water was deep enough to permit ocean currents to run.

Now, as regards the shallow sea over which the Jeannette drifted: Is this shallow sea caused entirely by the silt of the great northern rivers, or is it partly caused by the erosion of the land? The islands that extend all the way from the Lena Delta to "Bennette," "Jeannette" and "Henrietta," like so many stepping stones from the mainland toward the Pole, were, in my belief, at no very distant period, part of the mainland of Siberia. They are daily being eroded by the drifting ice pack; and, in time, nothing but the bare rocks will remain of these islands.

During our short stay on these islands, while on our march to the south, and while we were in the Lena Delta, the land was not making, but the daily evidence of the constant washing away by sea and ice floe, or melting snow, and occasional rain, showed that the islands were being denuded and eroded away.

I saw, on the banks of the Lena Delta, immense trunks of trees, with roots attached, that had apparently fallen *in situ*. Forty feet above the bed of the river, these lands were gradually washing away. These lands and the islands of the Arctic sea still show the remains of the mammoth which, without doubt, was a native of the mainland, and of the islands when they were part of the mainland. We found remains—tusks and teeth of the mammoth—as far north as Bennett Island, and, I doubt not, had time sufficed, similar remains would have been found on the other islands visited by the Jeannette.

I have thus digressed, gentlemen, from the main question of Dr. Nansen's drift, in order to justify the theory of a shallow sea more than 1500 miles in extent, east and west, though perhaps local in its northerly extension.

And now that Dr. Nansen has made the most magnificent drift on record, attained the highest latitude known to man, and made the most fortunate and masterly retreat, let us say, "Well done,

Nansen!" and let us plan the next possible drift from the east toward the west to make a high northern latitude, reaching, if possible, within marching distance of the Pole.

If Dr. Nansen is correct in his conjecture that we have deep water and broken ice, with open "polynias" all the way to the Pole, and, if my theory of a solid ice cap at the Pole (like an inverted saucer) is wrong, let us theorize a little further, and seek the best place to put a ship in the pack for such a drift as is contemplated. Let us see where our ship, if she holds together (which is doubtful), or if not crushed (possibly being buried in the overlapping and underrunning floes), let us conjecture, I say, the best place to put the ship in the pack for such a drift.

Dr. Nansen took several months to proceed from Norway, along the coast of Siberia, toward the river Alaneck, before he pushed north to take up the drift about where the Jeannette let go and sank in thirty-four fathoms of water, thus losing valuable time after leaving any source of supplies.

We must get north as rapidly as possible after leaving our last depot of provisions, so that if Dr. Nansen's theory of the Arctic ocean currents and of the ice conditions toward the Pole be correct, I believe that the proper place to put a ship in the ice will be through Bering strait. We should keep along the east edge of the pack in about longitude 165° W., attaining the highest possible latitude, and westerly longitude, culminating together. Then we should push the ship into the pack as far as possible to the northward and westward, and await the fulfillment of the prophecy of one of the jolly whalemen I met at San Francisco. He said: "Melville, push her into the ice at about the point I have mentioned, and you will either go to the Pole or to hell, and I believe the chances are about even." I can't agree with my whale-fisher friend about the hell part of the business, for true philosophers have a right to disagree about that. I do believe, however, from the information we have gained from the drift of the Jeannette and of the Fram, that vessels of any kind, such as casks or driftwood, will come out by way of the Spitzbergen—though not necessarily across the Pole. The only reason for sending in ships and men is that there may be observers to make a daily record of events, and of phenomena, such as latitude, longitude, soundings, daily drift, dredging the ocean's bottom if possible; in fact, recording all the phenomena proper on such an expedition. But for this, I say, a

hundred oaken casks, properly numbered, made after the manner of a beer keg of twenty gallons capacity, properly hooped, and the ends extended out to complete a parabolic spindle, would demonstrate the drift. At the end of four or five years, we might begin to look for the beer kegs between the Spitzbergen and Greenland. And now, as regards the work of our honored guest this afternoon:

His is the honor to have reached the "Farthest North," the *Ultima Thule*, that has defied the best blood and brains for three centuries. He it was who conceived the grand thought of making that most perilous drift, though he knew not how long it might last, nor whether his good ship and ship's company would ever drift out of the terrible unknown sea of ice and snow. His was the honor—after waiting months and years for the slow drift, and becoming impatient of the gods of ice and snow—to break away from the good ship in order to add a few more miles to his northern journey; and, taking his life in his hands, with but one solitary human companion, to make the long and dreary march to Franz-Josef Land. And to what purpose? That we, the eager, driving, working world, might have that knowledge which is power, wealth and happiness.

And let me ask my hearers this afternoon, What better school of heroic endeavor for our lusty youth than the Arctic ocean? There, amidst the silence of the eternal ice and snow, man can commune with the God of Nature in the hushed stillness that brings awe, but not fear, to the soul of the intrepid explorer, and there he receives the inspiration that spurs him onward in his search for the great unknown!

This, gentlemen, is Dr. Nansen, the guest whom we delight to honor, who among Arctic explorers is "the noblest Roman of them all."

PROF. ANGELO HEILPRIN:

Mr. President, Ladies and Gentlemen:—I was asked to speak this afternoon, and inasmuch as my resources in Arctic exploration are extremely limited, it is doubtless expected of me to say something on the scientific aspect of the subject, something of what remains to be done and something that has been done.

The question of the existing and past relations of the land and

water areas in the far north is an exceedingly interesting one to the geologist. I have given it a considerable amount of attention, but have arrived at no absolute conclusion to which I should like to commit myself at present. For some months past I have been engaged in the preparation of a geological map of Arctica, more particularly with reference to the results obtained by recent explorations. It is hardly necessary for me to state with what expectancy we are looking forward to the publication of the minute geological details which have been obtained by Dr. Nansen.

As geologists, we have gone sufficiently far to be able to state certain facts. Perhaps the most important of these is the very strong likelihood that, where we find to-day the deep ocean discovered by Dr. Nansen in place of the shallow sea that was thought to exist in the far north, its place was at a period not so very remote covered by land, and instead of a polar sea we had once a polar continent. Dr. Nansen has given to us very conclusive evidence as to the condition of Siberia at the not very remote period when in the general temperate regions of the north we had glaciers running down different mountain slopes, extending to the lower valleys, cutting out the fjords and valleys in the Scandinavian peninsula, like those which we to-day find in Greenland. Since that time, not more perhaps than fifty, seventy, or a hundred thousand years ago, the condition of the country has entirely changed, and changed to such an extent as to have deceived the geologists into the belief that there never was a glacial period touching the Siberian frontier. The discovery made by Dr. Nansen, and still earlier that of the Russian traveler and geologist, Baron Von Toll, who seemingly found a fragment of the old glacial ice existing to-day, and in addition the remains of animals, such as the tiger and rhinoceros, in the deposits of the New Siberian Islands, speak conclusively of great changes of climate and of oceanic configuration.

One great pleasure I experienced on the comparatively small venture I made in the north was in searching in the deposits of Atanekerdluk, Greenland, in approximately latitude 70° N., for the remains of old foresters, the history of a forest of warm temperate aspect, with trunks and leaves indicating a growth largely identical with or similar to that found to-day in Japan, and in localities where the redwood grows in the United States, and where we have poplars, elms, maples and oaks. The dimensions of the trees measured perhaps a hundred feet or more in height; to-day

the full height of vegetation of the same region is measured by six, eight and ten inches.

The evidence appears conclusive to my mind that we had the whole northern part of this tract of the world covered by a land-mass uniting Greenland not only with Spitzbergen but also with Franz-Josef Land and northern Siberia. Dr. Nansen, I believe, gives the best evidence for assuming that Franz-Josef Land is merely a fragment of what was once united with Spitzbergen; and if we had this connection it is practically certain that its relations were continental. What the result of such continental association may have been geologists have not yet been able to determine, but it will be one of the objects for explorers to make clear to us in the future.

I think it was the Austrian geologist, Prof. Eduard Suess, who first clearly pointed out the enormous changes that are taking place on the face of the earth through downward breakages, and that even the Atlantic ocean is but a depression of a comparatively recent date (of course from a geological point of view). It may not have been in existence more than 200,000 years, possibly for one or two million years. In the Arctic regions we have evidence that what is now water was once land, not very many thousands of years ago. A second proposition brought out by Dr. Nansen in reference to the relation that Bering Strait bears to the geology and geography of the region of land to the north, points to its having been opened in comparatively recent times, and that breakages are taking place to-day we have the best of evidence. The eastern remnants of the old Asiatic connection, which at one time extended to the outlying islands, are monuments of this form of destruction.

This largely indicates the direction in which to look for the solution of the problems that the results which Dr. Nansen has given to us have raised. Scientific expeditions have been fitted out from New York to explore that very Asiatic tract for further evidences of these breakages. We know, too, that the foremost explorer of this city—I refer to Lieut. Peary—is preparing for an expedition to penetrate into the solitudes of the northernmost part of Greenland and of the regions beyond; and we have learned from recent reports that Capt. Sverdrup is at the present moment preparing for another exploration of the far north to supplement the brilliant results of Nansen.

It is not my intention to detain you longer, and I will only

express the hope that expeditions of this kind may continue to be sent out until the entire northern tract is known to us in exactly the way that much of it has been made known by Dr. Nansen.

Stated Meeting, November 5, 1897.

Vice-President PEPPER in the Chair.

Present, 28 members.

Mr. Theodore N. Ely and Mr. Richard H. Sanders, newly elected members, were presented to the Chair, and took their seats in the Society.

Acknowledgments of election to membership were read from Mr. George Wharton Pepper, Commodore Melville, Mr. Gregory B. Keen, Mr. George Vaux, Jr., Hon. Wayne MacVeagh, Mr. John C. Smock, Hon. Grover Cleveland, Prof. William Libbey, Capt. Alfred T. Mahan, Prof. Woodrow Wilson, Dr. George A. Piersol, Prof. Lightner Witmer, Prof. James M. Baldwin, Mr. Richard H. Sanders, Mr. James S. deBenneville, Prof. Henry M. Howe, Mr. James B. Leonard, Prof. Edward H. Williams, Prof. H. Morse Stephens, Mr. William Tatham, Mr. Clarence B. Moore, Mr. Charles R. Hildeburn.

Donations to the Library and Cabinet were reported, and thanks were ordered for them.

The decease of the following members was announced:

Prof. James Ellis Humphrey, of the Johns Hopkins University, on August 17, 1897, at Jamaica, W. I.

Justin Winsor, LL.D., Librarian of Harvard College and President of the American Library Association, at Cambridge, on October 26, 1897, æt. 86.

John Sartain, at Philadelphia, on October 25, 1897, æt. 89.

The Society resolved itself into the Committee of the Whole, and proceeded to the consideration of the proposed amendments to the Laws.

The Society adjourned until Wednesday evening, November 10, at 8 o'clock.

Adjourned Stated Meeting of November 5, 1897, November 10, 1897.

Vice-President PEPPER in the Chair.

Present, 20 members.

The Society met pursuant to adjournment, and resolved itself into the Committee of the Whole, with Mr. Garrett in the Chair. The Committee resumed the consideration of the proposed amendments to the Laws.

The Committee of the Whole rose and reported, and on motion the meeting adjourned to Wednesday evening, November 17, at 8 o'clock.

Adjourned Stated Meeting of November 5, 1897, November 17, 1897.

Mr. GARRETT in the Chair.

Present, 14 members.

The Society resolved itself into the Committee of the Whole, and resumed the consideration of the proposed amendments to the Laws.

The Committee of the Whole rose and reported, and the Society was adjourned by the presiding member.

Stated Meeting, November 19, 1897.

Mr. RICHARD WOOD in the Chair.

Present, 10 members.

Letters of acknowledgment of election to membership were read from Dr. E. R. Squibb, Sig. Rodolfo Lanciani and Mr. Charles D. Walcott.

Donations to the Library were reported and thanks were ordered for them.

The decease of the following members was announced:

Mr. William Woodnut Griscom, of Philadelphia, on September 24, 1897, æt. 46.

Dr. Harrison Allen, at Philadelphia, on November 14, 1897, æt. 56.

Mr. R. H. Mathews presented a paper on "Rock Carvings and Paintings of the Australian Aborigines."

The Society resolved itself into the Committee of the Whole, and continued the consideration of the proposed amendments to the Laws.

The Committee rose and reported. The Society resumed its session, Vice-President Pepper in the Chair.

The Finance Committee reported upon the legacy of Henry Phillips, Jr., deceased.

The meeting was adjourned by the presiding officer.

ROCK CARVINGS AND PAINTINGS OF THE AUSTRALIAN ABORIGINES.

(Plate X.)

BY R. H. MATHEWS, L.S.

(*Read November 19, 1897.*)

Introductory.

The wide distribution throughout Australia of these native drawings would lead us to expect that the figures of animals and various objects carved upon large rocks—and the groups of hands, varying in number and in relative position, as well as weapons and other tribal devices painted on the walls of caves—had some symbolical meaning in connection with the myths and superstitions of the natives, or were commemorative of events and scenes in the history and life of the tribes. Most of the figures of animals were probably intended to represent the totems of the different families; but it seems reasonable to suppose that some of the smaller drawings and

nondescript devices are the result of idle caprice. The production of some of the larger groups—both of carvings and paintings—has been a work of immense labor, and it is unlikely that the natives would have taken so much trouble for mere amusement.

Aboriginal drawings are almost everywhere of the same character, with but little variation either in the subjects treated or in the style of workmanship. They consist chiefly of stenciled and impressed hands, outline drawings of human forms, animals and a few nondescript devices. In many of the caves we find groups of lines varying in length from about four inches to two feet. Sometimes the series consists of two or three lines; in other cases there are as many as about a dozen. They are generally drawn vertically or only slightly inclined, but are occasionally met with in a nearly horizontal position. The native artists had no idea of perspective, and their figures are not copied from nature, but are apparently drawn according to some conventional pattern which has probably been handed down from a remote period. The stenciled drawings cannot be called copying from nature, and may, therefore, be included in the conventional type.

Owing to our limited acquaintance with the subject, it would obviously be premature at present to advance any far-reaching theory as to the signification of these drawings. What we should endeavor to accomplish is the collection of all the facts now obtainable respecting these works of native art, by careful observation and inquiry in all parts of Australia. This would, I feel convinced, yield results of more than ordinary interest. The information thus gathered should be systematically compared and classified, from which it may be possible for us to arrive at some definite conclusion in reference to the purpose of these drawings, and perhaps furnish an important link in regard to the prehistoric colonization of this continent. This work should be undertaken without delay, because the farther we get away in point of time from the period of production of these pictures, the more difficult will it obviously become for us to obtain satisfactory explanations as to their meaning and origin. There are many difficult points which require much closer attention than they have yet received.

Writing under the date of February, 1788, Capt. Watkin Tench mentions some carvings seen by him upon rocks in the vicinity of Sydney;[1] and in January, 1803, Capt. M. Flinders discovered some

[1] *A Narrative of the Expedition to Botany Bay* (1789), p. 79.

rock paintings on Chasm Island, in the Gulf of Carpentaria.[1] These are the earliest authentic records of the discovery of carvings and paintings respectively in any part of the Australian continent, so far as I am aware. Since that period rock paintings have been found in several places in West Australia, South Australia, Victoria, Queensland and New South Wales. The rock carvings have also been observed in a few localities, long distances apart, in all the colonies mentioned with the exception of Victoria. The fact of these carvings not being reported in Victoria may probably be attributed to their having escaped the notice of investigators rather than to their non-existence.

Among the Darkinung tribe of aborigines, who occupied the country from the Hunter river to the Hawkesbury, I had the good fortune to meet a few natives who told me that when they were boys they had seen both painting and carving on rocks done by their countrymen, between the years 1843 and 1855, and it is probable that the practice was continued for some years later. From the last-mentioned date to the present the blacks have disappeared very rapidly by death, and the few survivors have lived chiefly amongst their white supplanters, abandoning most of their former customs.

To those who may be desirous of taking part in investigations respecting this subject a few practical directions relating to taking the necessary notes and the subsequent preparation of the plates for publication may be found of some assistance. The investigator should provide himself with a suitable note-book, a pencil, a tape measure of thirty-three or sixty-six feet in length and an ordinary pocket compass.

On reaching a cave containing paintings a careful sketch of all the figures in the relative order in which they appear upon its walls should first be made. Then note down the dimensions of every figure in this sketch, and at the same time fix by measurements their relative position to each other. If the paintings consist of different colors these should be carefully noted in the sketch. The dimensions of the cave should be measured, and the direction which it faces should be taken with the pocket compass; the bearing and approximate distance from some conspicuous or well-known point should also be stated, as this information will greatly facilitate its identification by others.

In making notes of carvings found on the surfaces of rocks a

[1] *A Voyage to Terra Australis*, Vol. ii, pp. 188–189.

similar course may be adopted, sketching and measuring each figure. The width and depth of the grooves along the outlines should be ascertained, and the direction which the rock slopes stated. In any case of either paintings or carvings where the investigator has not time or is unable for any other reason to copy the drawings, he should describe them as fully as possible, and state their geographical position as nearly as he can, for the purpose of enabling others to find them at any future time.

In reproducing cave paintings from the notes taken in the field they should first be outlined in pencil in their relative positions from the sketches and measurements given in the field book, and afterwards drawn in the colors in which they appear on the rock. The carvings will be reproduced in the same manner and then drawn in with Indian ink. Plates for publication should be drawn the size, or some multiple of the size, of a page of the journal in which they are to appear. It is generally found more convenient, especially if the objects are small or numerous, to draw the plate on a larger scale than that required, because it can afterwards be reduced by photography or otherwise to the proper size for publication.

In describing the rock pictures of the Australian aborigines and explaining how they were executed by the native artists, it will be desirable to treat the subject under two divisions, one being headed "Carvings" and the other "Paintings." In the former the outlines of the figures were in some cases cut and in others ground into the surface of the rock with sharp-pointed pieces of stone; in the latter the pictures were painted on the rock in the required colors; different methods being employed in doing the work.

Rock Carvings.

Rock carvings are found in districts abounding in large masses of rock, chiefly of the Hawkesbury series, but sometimes granitic and metamorphic rocks are used, where the softer sandstones are not available. Occasionally the rock surface containing the carvings is almost level with the surrounding land, and in other cases the drawings have been executed on the tops or sides of rocky masses several feet high. Some of the smallest of the rock surfaces on which these delineations appear do not exceed ten feet square, but they are generally much larger, and in a few places the table of rock, intersected here and there by fissures, was scarcely less than two

acres in extent, the carvings being numerous and widely scattered over it. These drawings are generally found on the tops of horizontal rocks, but are sometimes met with on the smooth walls of rocks occupying various slopes between the horizontal and the perpendicular position.

Denuded rocks are more general on the tops and sides of hills than elsewhere, owing to the soil and disintegrated matter being carried away by the weather to lower levels, hence we find these carvings more numerous in such situations than in the valleys, where masses of rock are less plentiful. It is obvious, however, that the natives, with their primitive tools, would be guided more by the suitability of the rock for their purpose than by its location; but where circumstances permitted, preference seems to have been given to rocks occupying prominent positions or which were situated in mountain passes along which the natives traveled from one part of their hunting grounds to another. Fine-grained sandstones of a durable character, with tolerably smooth surfaces and in dry situations, appear to have been chosen.

In nearly all carved figures, owing to age or weathering, the grooves along their outlines have assumed the same color as the original undisturbed surface of the rock. Some of them can be seen without difficulty, but numbers of them are so much defaced by long exposure to the weather that it requires some practice to be able to distinguish them, and they would be passed by unobserved by any person unaccustomed to them. They are more easily seen on sunny than on cloudy days on account of the light falling on all parts of the figure when viewed from different standpoints. The best time to observe those which are very faint is either on a dewy morning shortly after sunrise, or any time after a shower of rain; the dew or the rain, as the case may be, collects in greater quantities in the grooves than elsewhere and indicates their position.

Some of the carvings are so indistinct that it is necessary to make a chalk mark along the grooves before a complete idea of the outline of the figure can be obtained. Most of them exhibit tolerably strong likenesses of the objects they are intended to represent, but some grotesque drawings occasionally met with were probably intended for legendary monsters, or creatures of the native artist's imagination.[1]

[1] For examples of these mythologic and strange drawings, see my papers in the following publications: *Proc. Roy. Soc. Victoria*, vii, N. S., Pl. ix, Fig. 10; *Proc. Roy. Geog. Soc. Aust.*, Qld. Brch., x, Pl. ii, Fig. 15; *Am. Anthrop.*, Wash., viii, Pl. ii, Fig. 30; *Journ. Anthrop. Inst.*, Lond., xxv, Pl. xvi, Fig. 6.

In the production of rock carvings three methods were employed by the native artists. 1. That most generally adopted was to cut the outline of the required figure on the rock. It is probable that the object to be delineated was first designed by making a mark with a piece of colored stone or hard pebble along the lines to be cut out. A number of holes were then made close together along this outline, and these were afterwards connected by cutting out the intervening spaces, making a continuous groove of the required width and depth. From the appearance of the punctured indentations made along the lines thus cut out, I am led to assume that the natives had a hard stone or pebble chipped or ground to a point and used as a chisel. Such a chisel could have been used either by holding it in the hand or otherwise and hitting it with another stone, or by fastening a handle to it and chopping with it in the same way that a tomahawk is used. As soon as the outline was chiseled out to the required depth, it is not unlikely that a stone tomahawk, in addition to the chisel, was used in completing the work, because the sides of the grooves were cut more evenly than would have been possible with such an instrument as that with which the holes were punctured. From the smoothness of the edges of the grooves in a few of the best executed figures I am inclined to think it probable that after the chiseling and chopping out was finished the edges were ground down by rubbing a stone along them, to give them an even and regular appearance.

2. In other instances the whole surface of the rock within the outline of the figure was cut away to the same depth as the exterior groove, as in the cases mentioned by Capt. Wickham in his description of the carvings on Depuch Island, on the coast of West Australia, published in the *Journal of the Royal Geographical Society*, London, Vol. xii, pp. 79–83.

3. Another method was to trace on the rock all the lines of the object to be drawn, and then to form a groove by repeated rubbing with a hard stone or pebble along the outlines which had been so designed until the entire figure was completed. Carvings executed upon rocks in this way have been observed in West Australia and in some of the other Australian colonies.

In a previous communication to this Society[1] I furnished a plate containing sixty-one figures of men, women and children, kangaroos, emus, fish, wombats, snakes, native weapons, etc., together with

[1] PROC. AMER. PHILOS. SOC., Vol. xxxvi, pp. 195, Pl. iv, Figs. 1–61.

some land and marine monsters the types of which do not exist in nature, so that it will not be necessary on this occasion to add any further examples of aboriginal carvings. The present article, taken in conjunction with my former paper, will be found to place the subject of Australian rock pictures in a tolerably complete form before scientific men who may be engaged upon similar investigations in America.

Rock Paintings.

Cave paintings are necessarily restricted to those parts of Australia in which suitable rocks for the purpose are obtainable. They are sometimes met with in weather-worn cavities at the bases of separate boulders, but much more generally in rocky escarpments, of more or less continuity, on the sides of hills or watercourses. These cavities or shelters owe their origin to the natural wasting away of a softer stratum of the rock, leaving a harder layer overhanging, which forms the roof of the cave. In most cases they get narrower and lower as they go back into the rock; but some are small at the entrance and become higher and larger as they recede, having a somewhat dome-shaped interior. Some of them are of great extent, being more than one hundred feet in length, upwards of twenty feet high and extending back into the rock about twenty-five feet; while some are merely shallow crescent-shaped hollows of small dimensions weathered out of the face of a boulder or escarpment.

Many of the larger shelters have been used by the natives as camping places for considerable periods. This is evident from the smoke stains on the roofs and also from the remains of ashes and cinders on the floors. In digging into some of these floors, fragments of the bones of animals, broken implements such as tomahawks, knives[1] and other articles used by the natives are found covered over with ashes and other *débris*, in some instances to the depth of one or two feet. These shelters are mostly found in the proximity of streams of a more or less permanent character, from which water was probably obtained for camp use during the occupancy of the cave. Very small shelters would obviously be unsuitable for residential purposes.

[1] See my paper on "Stone Implements Used by the Aborigines of N. S. Wales," *Journ. Roy. Soc. N. S. Wales*, xxviii, p. 304, Pl. xliii, Fig. 2.

Most of the paintings are executed on the cave walls, but they are not infrequently drawn on the roofs, and are sometimes found in both these positions in the same cave. They are generally within the reach of an individual standing on the ground, but in a few instances I have found them at heights varying from eight, twelve and eighteen feet above the floor. In such cases it is likely that the natives stood on ledges of rock which have since weathered away, or on a staging erected for the purpose.

These paintings are nearly always drawn on the natural surface of the rock, but in some cases I have found that the cave wall had previously been painted a different color to that employed in the figures executed upon it. In one case the wall had first been colored red and on this background the figures had been drawn in white.[1] A similar instance of white painting on a ground of red ochre rubbed on the cave wall is mentioned by Capt. P. P. King[2] as having been observed by him in 1821 at Clack's Island, Prince Charlotte's Bay, Queensland. Capt. Grey states that the rock around one of the figures seen by him in West Australia in 1838 was painted black in order to produce the greater effect.[3] In some of the caves visited by me I found that the walls had been blackened before the paintings were made upon them.[4]

Owing to the weathering of the cave walls, in some instances the paintings are barely discernible; and in such cases I have found that one can see them better by standing several yards off than when very close to them. It is well to observe them from more than one standpoint, so that they may be seen with the light falling upon them in different directions, for the purpose of bringing into view faint lines which might otherwise escape notice.

Throughout my observations respecting this subject I have found that the natives in selecting rock shelters in which to produce their paintings always chose those whose walls consisted of smooth surfaces on which the objects could be delineated and at the same time sufficiently hard to be durable. Caves consisting of soft, friable sandstone, or which were situated in damp localities, or were exposed to storms, were rejected as unsuitable. I have also found that far the greater number of these shelters have a northerly aspect,

[1] *Proc. Roy. Geog. Soc. Aust.*, Q. Branch, x, p. 65, Pl. ii, Fig. 8.
[2] *Survey Intertropical Coasts of Australia*, ii, pp. 26, 27.
[3] *Two Expeds. N. W. and W. Australia*, i, p. 202, Fig. 1.
[4] *Jour. Anthrop. Inst.*, xxv, pp. 157, 158, Pl. xiv, Fig. 2.

thus receiving more or less of the sun's rays on every sunshiny day. In the large number of these rock shelters inspected by me those which were the most exposed to the sun's rays were the best preserved; and it would appear from the fact that most of them face the direction of the sun that this was known to the aborigines.

Aboriginal rock paintings have been executed in three different ways, viz., stenciled, impressed and outlined. 1. In the stencil method the extended hand was placed firmly on the smooth surface of the rock and the required color blown or squirted over it out of the mouth. Sometimes the rock was first wetted and the color blown in a dry state around the object; in other instances the color was wetted and was then squirted out of the mouth. Drawings done in the last-mentioned way can be easily distinguished from those stenciled with dry powder. This method of drawing was also frequently used in representing native weapons such as tomahawks, boomerangs, waddies, etc. Small animals such as fish, human feet and the feet of animals are also sometimes shown in this way. The color in some of the larger figures appears to have been applied in a wet state with a tool similar to a brush or mop.

In many of the stenciled pictures of the hand it is probable that the latter was held in position on the rock and the color applied by the same individual; but in representations of feet and native weapons, some of the latter being three or four feet in length, it would be necessary for two or more persons to participate in the work. A modification of this method was to previously color the surface of the rock and afterwards to stencil the hand or other object upon it in a different color. This mode of drawing was very effective, especially when the ground was red and the stenciling was done in white.[1]

Stenciled drawings of the shut hand are occasionally met with. In these cases the hand with the fingers shut, but the thumb extended was placed against the rock and stenciled in the usual way.

2. In the impression method the palm of the hand of the artist was either rubbed over with a liquid color or was dipped into it, and while wet was firmly pressed against a smooth surface on the cave wall. Upon removing the hand, the colored impression of it was left clearly defined upon the rock.

[1] For an example the reader is referred to the cave described by me in the *Proc. Roy. Geog. Soc. Aust.*, Q. Branch, x, pp. 46–70, Pl. ii, Fig. 8.

A variation of this method of drawing was to impress the hand in the manner described and before removing it from the rock to squirt a different color around its margin. This may be more correctly called a combination of the impression and stencil methods.

In the districts visited by me in collecting information on this subject I have found impressed hands[1] in comparatively few caves, the stencil method being that generally adopted. It may be that impressed hands had some particular meaning. In both these methods of drawing it was always the palm and never the back of the hand which was used.

3. Objects which could not be either stenciled or impressed, such as men, animals and a number of nondescript figures and devices appearing on the walls of these rock shelters, have been drawn in outline in the color selected for the purpose. In some cases the objects are shown in outline only; in other instances the space within the outline is painted with a solid wash of the same tint; whilst not infrequently this space is shaded by means of lines drawn either all in the same color or in two or more different tints.

It is not very clear what the nature of the coloring matter was in all instances, but it undoubtedly possessed the durability of an ordinary pigment. In the drawings which appear in red there is no doubt that most of them are done with red oxide of iron, found as a clay and known as red ochre. The white color would probably be pipe clay or fine white ashes from the camp fire. The few drawings done in yellow are produced by an oxide of iron found as a clay in the same districts where the pipe clay and red ochre occur. The black color appears to have been done with charcoal or soot.

In cases where it was necessary to use any of these colors in a liquid form they were first reduced to a powder and were then mixed with water or with oil obtained from some animal. When applied in a dry state a piece of the required color, as a lump of red ochre, or pipe clay, or charcoal, was held in the hand of the operator and the necessary lines drawn with it upon the rock, the surface of which was probably first moistened with animal fat or water

[1] The earliest reference I can find to the "impression method" is that by Sir George Grey. He states that in a cave in the district of York, West Australia, there is "the impression of a hand which had been rubbed over with red paint . . . . and then pressed on the wall" (*Two Expeds. N. W. and W. Australia* (1841), Vol. i, pp. 260, 261).

along the outline of the figure to be drawn, which would have the effect of assisting the color to penetrate it.

Whether the color was applied as a liquid or a solid, water or grease appears to have been employed to work it into the surface of the stone and give it greater permanency. This is easily demonstrated by rubbing the figures with a wet cloth, which has no effect upon them; but if the same test be applied to the initials of white visitors written with chalk or charcoal in some of the shelters they rub off at once.

Vegetable colors were also known to the aborigines. Mr. E. Stephens says[1] that the natives of the lower Murray river and Adelaide plains painted red bands on their shields by means of the juice of a small tuber which grew in abundance in the bush. Sir George Grey stated[2] that he imagines that the blue color used in paintings seen by him on the Glenelg river in West Australia was obtained from the seed vessels of a plant very common there, which on being broken yielded a few drops of a brilliant blue liquid. I have myself stated[3] that the apple tree and also the grass tree of Australia yield a red gum or resin, which has the property of staining anything a red color.[4]

Explanation of Plate X.

All the figures represented on this plate are drawn to scale from careful sketches and measurements taken by myself, and the position of each cave on the public maps is accurately described by reference to the nearest purchased land in the vicinity. All the caves are in New South Wales.

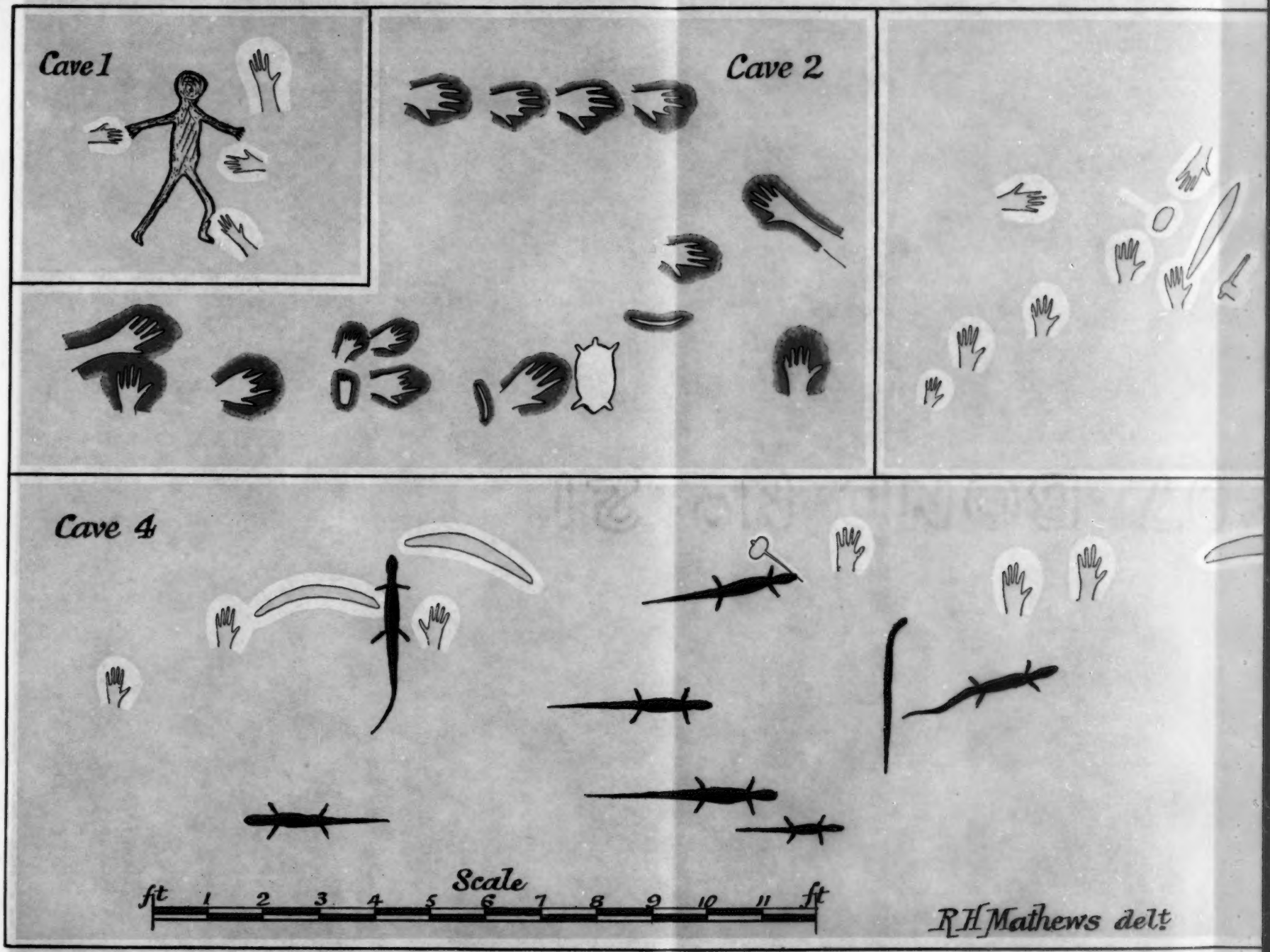
Cave 1 consists of a weather-worn cavity in a large boulder of Hawkesbury sandstone within Portion No. 6, of fifty and three-quarters acres, in the parish of Bulga, county of Hunter. The interior is forty-two feet long, seventeen feet from the front to the back wall and eight and a half feet high. It faces S. 70° E., and has apparently been used as a camping place by the aborigines.

[1] *Jour. Roy. Soc. N. S. Wales*, xxiii, p. 487.

[2] *Two Expeds. in N. W. and W. Australia*, i, pp. 262, 263.

[3] *Proc Roy. Soc. Victoria*, vii, N. S., p. 146.

[4] Mr. E. M. Carr mentions that the natives of the Leichhardt river, Queensland, imprinted their hands, stained with red ochre or blood, on a conspicuous tree (*The Australian Race*, ii, p. 301).


Cave 1
Cave 2
Cave 4
Scale
ft 1 2 3 4 5 6 7 8 9 10 11 ft
R H Mathews delt

Cave 3
R.H.Mathews delt

The plate shows four hands—one of them being the right—done in white stencil. Amongst these is a human figure in black outline filled in with shading of the same color. There is permanent water in Wareng creek, five or six chains distant.

Cave 2 is situated within Portion No. 41, in the parish of Coolcalwin, county of Phillip, about ten chains from Jolly's Downfall creek, in which water is permanent. The cave is in a large isolated sandstone boulder, near the base of a rocky spur, and the entrance faces the northwest, so that it gets the afternoon sun throughout the year. Its length is fourteen feet, depth eighteen feet, with a height at the entrance of three feet, which increases to five and a half feet inside. The rocky floor has several natural interstices extending the whole length of the cave, with a few others nearly at right angles to them, caused by the disintegration of the softer parts of the sandstone, giving the floor the appearance, at first sight, of having been paved.

All the drawings in this cave, except the turtle, are executed in the stencil method, in red color. There are fourteen hands, several of which have some of the fingers missing; two are smaller than the rest; and in one the arm is shown nearly as far as the elbow. There is a rude representation of what may be either a turtle or a beetle, outlined in black and filled in with a wash of white. A child's right foot and two small bent objects complete the drawings.

Cave 3. This rock shelter is on Portion No. 81, of one hundred and eight acres, parish of Bulga, county of Hunter. Its length is fifty-four feet, depth eleven feet, and its height varies from four and a half to six and a half feet—the roof being level, but the floor irregular. The cave faces N. 20° E., and looks out upon a small watercourse. These drawings are all upon the roof, and are done in white stencil. They consist of eleven hands, one of which is very small; two native tomahawks with handles attached, and two other weapons. The position of the hands as well as the weapons is unusual and were probably intended to convey some meaning.

Cave 4. This cave is situated within Portion No. 31, of sixty-one and a half acres, parish of Merroo, county of Cook, near the right bank of a small gully in which water can be obtained during the winter months. It has been worn out of a low escarpment of Hawkesbury sandstone and faces the west; its length is twenty-three and a half feet and the depth eleven feet. Owing to the dome-

shaped roof, the height inside is seven and a half feet, whilst that at the entrance is only five feet.

The drawings consist of a number of hands, ten of which are still distinguishable; one tomahawk with handle, and three boomerangs—all executed in white stencil. There is also a drawing which appears to be intended for a snake or an adder, and eight iguanas, varying in length from two feet to three and a half feet. The snake or adder and the iguanas are drawn in black outline, shaded with a wash of the same color within their margins.

NOTE.—I wish to make the following corrections in my paper on "Australian Rock Carvings," published in the PROCEEDINGS of this Society, Vol. xxxvi, No. 155:—

At page 200, line 5, for "western" *read* "northern."

At same page, line 6, for "No. 23" *read* "No. 83."

At page 203, line 8, for "portion" *read* "position."

At page 205, line 20, for "lind" *read* "line."

Figs. 39, 42 and 43, are on the same rock as Fig. 26.

Stated Meeting, December 3, 1897.

Vice-President PEPPER in the Chair.

Present, 19 members.

Mr. George Vaux, Jr., and Mr. William Tatham, newly elected members, were presented to the presiding officer, and took their seats.

Mr. Edmunds, by unanimous consent, offered the following:

Resolved, That a Committee of five members be appointed by the Chair to report as soon as may be, such further amendments to those proposed by the Committee reporting the Laws now under consideration, as shall by them be deemed best, and especially to provide for a separation of the Laws of the Society required by its Charter, from the regulations of administration and order which need not be in its Charter Laws, and that meantime the proposed revision of the Laws now pending, stand over from stated meeting to stated meeting until disposed of.

Adopted.

The Chair appointed the following as the Committee: Hon George F. Edmunds, William A. Ingham, Esq., William P. Tatham, Esq., Samuel Dickson, Esq., and Richard L. Ashhurst, Esq.

Donations to the Cabinet and Library were announced, and thanks were ordered for them.

The death of Dr. George H. Horn, on November 24, 1897, æt. 58, was announced.

The following papers were read by title, as follows:

"The Passamaquoddy Wampum Records," by J. Dyneley Prince, Ph.D.

"The Ethnic Affinities of the Guetares of Costa Rica," by Daniel G. Brinton, M.D.

"The Sources of Goethe's Printed Text: Hermann and Dorothea," by Prof. W. T. Hewett.

Mr. McKean read the reports of the Committee on the Henry M. Phillips Prize Essay Fund and of the Trustees of the Building Fund.

Dr. Frazer made a communication, illustrated by photographic views, on "The Ourals and the Caucasus."

The annual reports of Treasurer and Finance Committee were read.

The rough minutes were read, and the Society was adjourned by the presiding officer.

THE PASSAMAQUODDY WAMPUM RECORDS.

BY J. DYNELEY PRINCE, PH.D.

(Read December 3, 1897.)

The Passamaquoddy Indians of Maine, who, together with the Penobscots, now occupy Oldtown on the Penobscot river as their headquarters, are members of the great Algonkin family which was in former times the dominant native race from Nova Scotia to the Carolinas. The language still in use among the Passamaquoddies[1]

[1] The Indians call themselves *Pestumagatiek* in their own idiom.

is a northern dialect of the Algonkin stock, very closely allied to the idiom of the Etchemins or Maliseets of New Brunswick and to that of the Abenakis[1] or St. Francis Indians of Quebec, and less closely, although nearly, related to the language of the Micmacs of Nova Scotia.

The Passamaquoddies, Penobscots, Maliseets, Abenakis and Micmacs call themselves by the common name *Wabanaki* or "children of the dawn-country,"[2] which was in earlier days the generic name of the entire Algonkin family. These five tribes seem to have been members of a federation both with one another and with the Iroquoian Six Nations, and the Passamaquoddies have preserved the traditions regarding both of these unions in their Wampum Records, the text and translation of which are given in the present article.

The records of an Indian tribe were in nearly all cases orally transmitted by elderly men whose memories had been especially trained for the purpose from their early youth. It was customary for these keepers of the tribal history from time to time to instruct younger members of the clan in the annals of their people. The records thus transmitted in the case of the Passamaquoddies were kept in the memory of the historians by means of a mnemonic system of wampum shells arranged on strings in such a manner that certain combinations suggested certain sentences or ideas to the narrator or "reader," who, of course, already knew his record by heart and was merely aided by the association in his mind of the arrangement of the wampum beads with incidents or sentences in the tale, song or ceremony which he was rendering. This explains such expressions as "marriage wampum" or "burial wampum," which are common among the Passamaquoddies and simply mean combinations of wampum which suggested to the initiated interpreter the ritual of the tribal marriage and burial ceremonies.

This custom of preserving records by means of a mnemonic system was peculiar to all the tribes of the Algonkin race as well as to the Iroquoian clans. Brinton refers to the record or tally sticks of the Crees and Chipeways as the "rude beginning of a system of mnemonic aids."[3] It seems to have been customary in early times

[1] The Abenakis who call themselves *Wabanaki* are at present a small clan resident at St. Francis near Quebec. They were at one time a powerful New Hampshire tribe.

[2] See Brinton, *The Lenape and Their Legends*, p. 19.

[3] *l. c.*, p. 59.

to burn a mark or rude figure on a stick suggestive of a sentence or idea. Brinton adds:[1] "In later days, instead of burning the marks upon the stick, they were painted, the colors as well as the figures having certain conventional meanings. The sticks are described as about six inches in length, slender, although varying in shape, and tied up in bundles." Among the more cultured tribes the sticks were eventually replaced by wooden tablets, on which the symbols were engraved with a sharp instrument, such as a flint or knife. The Passamaquoddies appear never to have advanced beyond the use of wampum strings as mnemonic aids.

I obtained the Wampum Records at Bar Harbor, Me., in 1887, from a Passamaquoddy Indian, Mr. Louis Mitchell, who was at that time Indian member of the Maine Legislature.[2] The MSS. which he sent me contained both the Indian text and a translation into Indian-English, which I have rearranged in an idiom I trust somewhat more intelligible to the general reader. Owing to the fact that the Indian text in Mitchell's MSS. is written syllabically, without any attempt at a division into words, much less into sentences or paragraphs, the difficulty of editing the same with even approximate correctness has been very great. I have followed almost exactly Mr. Mitchell's extremely variable orthography, although tempted in many cases to depart from it, as he has written what is evidently the same sound sometimes in as many as three different ways. Thus, he was clearly unable to distinguish between *j* and *ch*, *a*, *u* and *e*, or *oo* and *u*, and he uses *k–c*, *kw–qu*, *b–p*, etc., apparently indiscriminately. I plead guilty in advance, therefore, to any errors which may occur in the original text, trusting that the interesting character and historial value of the records themselves will justify their publication in the state in which I offer them.

[1] *l. c.*, p. 59.

[2] The Passamaquoddy and Penobscot tribes send a representative to the Maine Legislature who is permitted to speak only on matters connected with the affairs of the Indian reservations.

The Wampum Records in Passamaquoddy.

Mechi mieu begokni tohocioltowuk k'chi ya wioo w'skittap epitjik wasisek nespi w'sikyojik yot mechi mipniltimkil ; nitt etuch alitt-huswinook negmaoo tepit-hodmotit chewi kegw layoo kegusitch eliyoek chewi layoo tech na neksayiu. Nitt etuchi m'sioo sise p'chittaketil kinwetaswinoo m'sitte elipitt w'skichin anquotch elquiyik sownisnook anquotch w'chipenook ketkik snoot segdenook ketkik k'ski yasnook. Pechiote pechiyik Wabnakik. K'mach w'sipkikm'n yaka keswook naga wew'chiyanya nitta tama wejiwetit w'tiyawa w'skichunoo kepechip-tolnen w'liagnotmag'n. N't ettlowsittgw-ton kisipootwusoo likislootemook. M'sitte tekepitt w'skichin kinwetto nitt k'chi lagootwag'n kitwitasso. M'sioo w'skichin nootek aknoomag'n m'sioo w'litt-hasoo. M'sioo w'siwatch yogonyalkatkisilet tekowm'k maltnitin. Nitt m'sioo kesookmik sittobjitakan opootwuswinoom. M'sioo kesookmik sittopetchitakan nissoo kessena agwam'k opootwuswinoom natchiwitchitagwik k'chi lagootwag'n kessena k'chi mawopootwuswag'n.

Nitt m'sioo kisma wewsettil nitt omache tipit-hodm'nya ta n'teh w'telook-h'dinya. Stepal m'sioo siwatch yokotit eli w'abli pemowsittit ; yotk k'chi sogmak w'tiyana-k't kihee yot elapim'k asittwechosyokw k'n'mittunen elipegak napttwuk kenemittonenwul kesek ewablikil yot'l pegaknigil tem'hig'nsis'l to (?) naga tapyik tepakw-yil chewi pooskenoswul oskemioo nitte m'sioo w'tlikislootm'nya w'tlagootinya ; nitt otaginwipoonm'nya kisook etuchi pootwusitit.

Nitt liwettasoo chikte wigwam. Yot w'kesekmenya etasikiskakil katama loo-wen-kelosioo m'sitte pootwuswin chewitpit-hasoo tanetch w'titm'n. Tan etuchi littootit tebaskuswag'n'l m'sitte w'tipithodm'nya tanetch likisi-chenetasso man'tim'k guni chikpultowuk topemlokemkil.

Apch etuchi apkw-timootit wigwam liwitassoo m'sittakw-wen tlewestoo nitt na guni omache pootwuswinya ; m'sioo potwooswin w'toknootm'n elippipyaks nage mech matnuttitit m'sioo eli w'sikyoltotitits guenipn'ltim'k ; nittlo alteketch tepnasko yotipit-hatosoo naga k'temakitt-haman w'tepittemowa w'towasismowa nega mamatwikoltijik; mechi mieu yokli-w'sikyaspenik tahalote saglit-hat w'sikap naga m'tappeguin. Nitt m'sioo mitte westotitit. Nitt likisloomuk w'tlitonia k'chi lakalosnihag'n naga tochioo opoom'nya

The Wampum Records in English.

Many bloody fights had been fought, many men, women and children had been tortured by constant and cruel wars until some of the wise men among the Indians began to think that something must be done, and that whatever was to be done should be done quickly. They accordingly sent messengers to all parts of the country, some going to the South, others to the East, and others to the West and Northwest. Some even went as far as the *Wabanaki*.[1] It was many months before the messengers reached the farthest tribes. When they arrived at each nation, they notified the people that the great Indian nations of the Iroquois, Mohawks and others had sent them to announce the tidings of a great *Lagootwagon* or general council for a treaty of peace. Every Indian who heard the news rejoiced, because they were all tired of the never-ending wars. Every tribe, therefore, sent two or more of their cleverest men as representatives to the great council.

When all the delegates were assembled they began to deliberate concerning what was best to do, as they all seemed tired of their evil lives. The leading Chief then spoke as follows: "As we look back upon our blood-stained trail, we see that many wrongs have been done by all of our people. Our gory tomahawks, clubs, bows and arrows must undoubtedly be buried for ever." It was decided, therefore, by all concerned to make a general *Lagootwagon* or treaty of peace, and a day was appointed when they should begin the rites.

For seven days, from morning till night, a strict silence was observed, during which each representative deliberated on the speech he should make and tried to discover the best means for checking the war. This was called the "Wigwam of Silence."

After this, they held another wigwam called *m'sittakw-wen tle-*

[1] According to Indian tradition, six Iroquoian tribes united in a confederation in the interests of peace. This was the famous league of the six nations: Onondagas, Mohawks, Oneidas, Senecas, Cayugas and Tuscaroras. The first five of these completed their league as early as the middle of the fifteenth century under the Onondaga chief Hiawatha. The object of the federation was to abolish war altogether (see Brinton, *The American Race*, pp. 82, 83). It is evident that the Passamaquoddy tradition embodied in this part of the Wampum Records refers to these proposals made by their Iroquois neighbors.

epasioo k'chi wigwam tebagalosneoo; na w'tlitunia ebiss oponmoonya omittakw-sowall nitt wen pelestowatt nitt etuch eshemhoottam yot'l eyilijil w'nijan'l tebakalusneoo. M'sitte na w'tachwiyik settswawall naka na mejimioo w'm'tutwatm'n w'kchi squt wa wechi skanekaswenook. Yot wechi mach-hak wababi tebaskuswag'n'l.

Nitt lagalosnihag'n'l ettli-n'settwasik spemek nitt nitmame lagootwi-kislootmewag'n m'sitte kesigpesitt w'skichin newanko kesookinito kenooklo kechayami milijpesw. M'sitte yokteke w'skichinwuk w'tachwi elyanya naga wiginya tebagaloosneoo teketch wen kegw liwableloket chiwisemha w'nikikowal w'tesemhogol; nitt ebis kisi mawettasiks nittlo tane teppo wigitt tebakalosneoo chejik s't'menal tan eyigil tebaskuswag'n'l kessena essemha. Nitt wigwam ettlinwasik tabakalosneoo hidmowioo m'sitte kesitt w'skichin kesittakw chewi sanke wipemowsoo. Katama apch chigawi yotoltiwun chewi lipemowsowuk tahalo wesi westoltijik witsegesotoltijik opeskon wenikicowa. Nittlo k'chi squt ettli w'sittwasik wigwamek hidmowiw m'sitte ta wut kiswichitakw w'skichin nittetch ettlositit squtek wela manch skat apch teke yiwibmes-honwal. Nittlo wenikigowal ettlin m'sitt woot wigwamek nitt k'chi Sagem Kanawak. Nitte lakaloshig'n naga hibis hidmowiw wababi tebaskuswag'nl. Tan wut pelsetek chewi mawe sagyawal ettli n'settwojik nitt m'sigekw kisittpiyak.

Nitte apch omach elok-h'dinya h'n'w'tlitunia apsegiguil w'tebaskuswag'nowal. M'sioo yot'l tebaskuswag'n'l chewi-littaswul wababik. Wechich kiskittasik tan teppo elikimwittpiyak elnogak m'sittech yo naga elimilichpegek wapap. Yot wapap elyot sagmak naga m'itapeguinwuk naga nipwultimkil. Elok-h'dimek tane etuchi metchmete sagem naga elipuskenoot eli-m'takittmowatil m'sitte w'skichinwuk. Wulasikowdowi wapap; wigwamkewi wapap.

westoo, or "Wigwam of Oratory." The ceremonies then began. Each representative recited the history of his nation, telling all the cruelties, tortures and hardships they had suffered during their wars and stating that the time had now come to think of and take pity on their women and children, their lame and old, all of whom had suffered equally with the strongest and bravest warriors. When all the speeches had been delivered, it was decided to erect an extensive fence and within it to build a large wigwam. In this wigwam, they were to make a big fire and, having made a switch or whip, to place "their father" as a guard over the wigwam with the whip in his hand. If any of his children did wrong he was to punish them with the whip. Every child of his within the enclosure must therefore obey his orders implicitly. His duty also was to keep replenishing the fire in the wigwam so that it should not go out. This is the origin of the Wampum laws.

The fence typified a treaty of peace for all the Indian nations who took part in the council, fourteen in number, of which there are many tribes. All these were to go within the fence and dwell there, and if any should do wrong they would be liable to punishment with the whip at the hands of "their father." The wigwam within the fence represented a universal house for all the tribes, in which they might live in peace, without disputes and quarrels, like members of one family. The big fire (*ktchi squt*) in the wigwam denoted the warmth of the brotherly love engendered in the Indians by their treaty. The father ruling the wigwam was the Great Chief who lived at Caughnawaga. The whip in his hand was the type of the Wampum laws, disobedience to which was punishable by consent of all the tribes mentioned in the treaty.

After this, they proceeded to make lesser laws, all of which were to be recorded by means of wampum, in order that they could be read to the Indians from time to time. Every feast, every ceremony, therefore, has its own ritual in the wampum; such as the burial and mourning rites after the death of a chief, the installation of a chief, marriage, etc. There were also salutation and visiting wampum.

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Elok-h'dim'k tan etuchi mechmete Sagem.

Tan etuchi mechinett sagem omutl'waqulm'n'l chewi temitaha naga n'kikw-wakw-san. M'sitte tan kesiyitt w'towegaknul w'tchapyil w'tumhigen naga w'mutewag'n w'skichinwuk w'nittagitmowawal enguchi g'dunweyin. Tan etuchi tepnasgoyak w'skichinwuk wikwmania pootwuswinoowo pootwuswinia wateplomania pili sagmal negootekmi katama w'kislomowyil sagmal. Nitte eli kisi-mawekislootmootitits nitt opechitakaya kinwetasswinoo newunol kessena kamachin hegwitnol hesgun elye Mikmakik, Kebeklo, Panwapskek welastogok sagem teli mechinett Pastemogatiek. Tan etuchi pechiyatit kinwettasijik elyatit Mikmakik nitte m'mittutil wechkiyak eguidin metenegnahasik w'kisin setumenya kigw ittmowio nitte sagem w'moweman oskmaknesum w'tiyan nitt wechkoyak kigw nitk kinwut wechipechijik. Nitt m'sitte wen wasisek nake epijik w'skittapyik m'tappyataswook wenachi asikwenya malemte eguayik. Nitte peskw w'gapetasin natuchio w'tlintowatmun n'skawewintowag'n'l. Nitt w'tali esui n'skawan elamkigap wiyalit. Malem te mechintoo nitte na yok wechiyojik peskw littposwin omilawiyan nitt na negum w'tasitetunan w'siwesul na negum w'wuskawan.

Malem te m'sioo mechi n'skaw-h'timek naga tuchioo omach yapasinya imye-wigwam'k w'naji mawehimyanya. Malem tech apch kisi-myawletwuk naga tuchioo lippan tanpunote wigwam'k. Nitt m'sioo wen peji ti epijik wasisek m'sioo w'tlapasinya w'naji w'lasikwawa s'sikiptinenawa naga na opummumya m'tewegon tesagioo wigwam'k ettli wechiwetit nitt naga tojio kchi-yawiwul w'skichin wutakewag'nl.

Elukemkil etchwi kisetuchil meskw kisi sepyatikw nitt amskwas welaguiwik eh'li wulit-has soeltowegw pemgowlutwuk. Nitt apch wespasagiwik yotk mejiwejik opetchitaganya pesgowal oskittapemwal sagmawigwam'k wutiyanya sagmal opawatmunia m'sitte w'unemyanya oskittapi gwandowanek. Nitte sagem w'takinwettuwan oskittapemomaweman gwandowanek naga apch w'taginwettuwan yohote wechi-welijihi. Nitt na kisi kusyapasitit naga tojoo omoosketunia wapapyil naga tojoo egitoso negett elikislotmotits. Nitt ettlowsitt Pestumagatiek w'kuskatam w'k'chi-w'skinosismowow ; nittlo k'pawatmag'nkil yot ettlowsiyan k'najiwichi kehman eliat-k'chi'w'skinosismul. Malem te nega kise westoltitit yotk wechiwejik nitt

Ceremonies Customary at the Death of a Chief.

When the chief of a tribe died, his flag-pole was cut down and burnt, and his war-like appurtenances, bows and arrows, tomahawk and flag, were buried with him. The Indians mourned for him one year, after which the *Pwutwusimwuk* or leading men were summoned by the tribe to elect a new chief. The members of one tribe alone could not elect their own chief; according to the common laws of the allied nations, he had to be chosen by a general wigwam. Accordingly, after the council of the leading men had assembled, four or six canoes were dispatched to the Micmac, Penobscot and Maliseet tribes if a Passamaquoddy chief had died.[1] These canoes bore each a little flag in the bow as a sign that the mission on which the messengers came was important. On the arrival of the messengers at their destination, the chief of the tribe to which they came called all his people, children, women and men, to meet the approaching boats. The herald springing to land first sang his salutation song (*n'skawewintuagunul*), walking back and forth before the ranks of the other tribe. When he had finished his chant the other Indians sang their welcoming song in reply.

As soon as the singing was over they marched to some *imwewigwam* or meeting house to pray together. The visiting Indians were then taken to a special wigwam allotted to their use over which a flag was set. Here they were greeted informally by the members of the tribe with hand-shaking, etc. The evening of the first day was spent in entertaining the visitors.

On the next day the messengers sent to the chief desiring to see all the tribe assembled in a *gwandowanek* or dance-hall. When the tribe had congregated there, the strangers were sent for, who, producing their strings of wampum to be read according to the law of the big wigwam, announced the death of the chief of their tribe, 'their eldest boy" (*ktchi w'skinosismowal*), and asked that the tribe should aid them to elect a new chief. The chief of the

[1] From here on the recorder mentions only the neighboring Algonkin tribes as belonging to the federation which he has in mind. The northern Algonkin tribes were very probably in a loose federation with the Iroquois merely for purposes of intertribal arbitration. These Algonkin clans themselves, however, seem to have been politically interdependent, as one clan could not elect a chief without the consent of all the others.

na sagem onakisinn na wutelewestoon w'tiyan w'pemowsowinoom nitt negum holithodmun wenajiwi-chakekemiw wicho keman w'siwesul kipnael. Nitt apch yotk wechiwejik onagesin w'teleweston olasweltum'n kisi weleyet sagman eliwulmatulit napch okisiyinya nega tojoo onestom'nya kisookch etuchiweswesittit.

Wechiyowitit nittech apch liwitasso eldagemk ekelhoochin malem te kisachwuk weswesinya. Wechiyawitit nitt sagem w'tokinwettuwan oskittapem nitk k'siwesnowook kisachwuk weswesinya katama kiseltumwownewin toji neksayiu omach-honya. Napch mosket-taso wapap kelhodwei naga w'tegitmunya w'tiyawa: n't yot etlowsit Mikmakik epit wasis w'skittap k'powatmagon k'chenesin apch wagisook nio nitt kigwusin katagonkuthag'n k'machkulit-hookowa. Nitt ittmowioo katama okiseltumwawun omach-halin.

Nitt apch elok-h'dim'k liwitasso n'skowh'din. Nitt apch sagem opechitagon oskittapem onachi ketonkatinya k'chikook nitt appi k'tunkatitit nitt w'telogw-sumnia tan eli pechputit m'sioo weyesis nepahatijihi malem te m'sioo kegw kisogwew. Nitt m'sioo macheptaso gwandowanek nitt ettli kitimawemittsoltitit naga kinwetowan nojikakolwet (*or* notgudmitt) w'talqueminowticook k'waltewall (*or* wikw-poosaltin). Nitt m'sioo wen w'nastowan. Elque milit nitte na w'quaskoltinya wasisek epitjik w'skitapyik pemip-hatijihi waltewa mosque weya malem te pechik sikowlutwuk gwandowanek. Nitte m'sioo t'holpiyanya pemkemigek nitt yotk nojitophasijik otephemwan yayate elapesitt. Yot nitt elwittasik elok-h'dim'k egelhodwi wikw-paltin; nitt kisapeseltitit omach yapasinya. Nitte apch neksayiu appat aptdoowuk. Nitt naga tochio h'nskowh'din nitt apch yotk wechiwejik onakisin peskw w'tlintowatm'nhichi eleyiks elittotits omesomsowuk peskwun kessena nisnol elintowatkil. Nitt na sagem wut wechi yot wenaskawan-na.

Malem te nitt mechintotim'k nitt sagem holpin eppasio gwandowanek kelnek pegholagnesis naga epesis nitte omache k'tumosin omachetemun opekholag'n naga otlintowatmun k'tumaswintowag'n'l. Nitt miswen onayinyan opemkan w'skittapyik epitjik pechiote wasisek nitt omikmow powl'tinya.

Nitt malem te mechitt piye apch naga tojoo apch otakinwipunmunia etuchi mach-hatit. Apch kisatchitit nitt apch sagem nimwul-k'd'minya hilelok-h'dimkil. Anquotch metch nichi kesspemi minwukelhak yot nitt eldakewag'n anquotch metch nihilente

stranger tribe then arose and formally announced to his people the desire of the envoys, stating his willingness to go to aid them, his fatherless brothers, in choosing a new father. The messengers, arising once more, thanked the chief for his kindness and appointed a day to return to their own people.

The ceremony known as *kelhoochun* then took place. The chief notified his men that his brothers were ready to go, but that they should not be allowed to go so soon. The small wampum string called *kellhoweyi* or prolongation of the stay was produced at this point, which read that the whole tribe, men, women and children, were glad to see their brothers with them and begged them to remain a day or two longer; that "our mothers" (*kigwusin*), *e. g.*, all the tribal women, would keep their paddles yet a little while. This meant that the messengers were not to be allowed to depart so soon.

Here followed the ceremony called *N'skahudin.* A great hunt was ordered by the chief and the game brought to the meeting-hall and cooked there. The *noochila-kalwet* or herald went about the village crying *wikw-poosaltin,* which was intelligible to all. Men, women and children immediately came to the hall with their birch-bark dishes and sat about the game in a circle, while four or five men with long-handled dishes distributed the food, of which every person had a share. This feast was called *kelhootwi-wikw-poosaltiu.* When it was over the Indians dispersed, but returned later to the hall when the messengers sang again their salutation songs in honor of their forefathers, in reply to which the chief of the tribe sang his song of greeting.

When the singing was over the chief seated himself in the midst of the hall with a small drum in one hand and a stick in the other. To the accompaniment of his drum he sang his *k'tumasooi-n'ta-wagunul* or dance songs, which was the signal for a general dance, followed by another feast.

The envoys again appointed a day to return, but were deterred in the same manner. As these feasts often lasted three weeks or a month, a dance being held every night, it was frequently a long time before they could go back to their own tribe, because the chief

kessena te peskw kisus etasi-welaquiwigil pemkak; nitt quenni wechi yot.

ELOK-H'DIM'K TAN ETUCHI ELYOOT SAGEM.

Malem te m'sigekw mitnaskiyi nitt naga toji sankiyiw omaja hapanya malem tech nitk pechiyik elyatit wecheyawitit nitte na omawemania opemowsowinomwa w'teginwetowania eli kisi-kiwkenitit eli pekwatotit wichoketwag'n. Miyawal te nitk na ketkik otapch-yanya ki w'kenitsepenik. Nitt w'chi-mach-yiw otaskowalmunia wechiyan nachiwichi sakmakatenik. Malem te pechiyik om'sioo nitt me (?) elok-h'dimkil-lelan nach sekeptin ewan nut pemkemek. Pechiyatil odenesisek kisi-pemkatil kisi-n'skowh'ditit.

Malem te tama nisook nekiwik naga omache hel-yanya m'tewagem'l n't sagem kitwi yot om'tewagwemul. Malem te kisachitt otemepelanya h'nitt peskw sagmak oponmowan naga w'nasettowan omannim'l naga na onas-hewhotlanya pileyal elequotewag'n'l. Nitt peskw sagem onestomowan yohot sagmal kisiyajik wutege k'chi-w'skinosismowa k'tachwi elokepa tan eli kisi wulasweyekw naga na k'tachichik s't'wania nekemch na elookil tan wechi miyawil wahod opemowsowinoom. Yot'l na echwi elokejil sagem w'tachiwi sagitonel m'sioo tan yoot'l nekachikil. W'tachwi klamanel chikow yoot'l timkil matn'toltimkil w'tachwi na kig-ha opemowsowinoom. Chikate w'pemowsowag'n lawutik.

Napch omach yot asinya gwandowanek w'nachmoyowag'nya. Napch sagem w'kutomasin naga wisek-han sagmal sagmaskw wisek-hod pili sagmal naka kiskamek.

Apch wespasakiwik naga okeptinen teboloman elwig'n'k keswuk nihitanke yachihi w'tliteboloma wataholoteh elitebolomoot sagem. Peskw na elipemket wut eli wisek-hot. Eli miloot o'manimwa aguami sagleyowal katik sagem napch wut piliwi sagem oskowiman naga onestomowan kesich pigak wutlokewag'nowal miyawal tena okisajin otewepoosan m'tewaguem. Nittle metewag'n-mel osagmamwal nitk gaptinek wiwunik apwihtowatijil ya te chikihig'n'l kelnajit ayat na tan teppo yot kegus ewabligik quasijik kemenia pekusek w'tachwi pekiyawal. Yot nitt itmowin w'tachiwi wulankeyowwowwal tan te quenowsiltil pemowsowag'nawa te w'tlipoonm'nia.

would detain them whenever they wished to return. Such was the custom.

The Ceremony of Installation.

When they reached home, however, and the embassies from the other *Wabanaki* tribes had also returned, the people of the bereaved tribe were summoned to assemble before the messengers, who informed them of the success of their mission. When the delegates from the other tribes, who had been appointed to elect the chief, had arrived and the salutation and welcome ceremonies had been performed, an assembly was called to elect the chief.

This took place about the second day after the arrival of the other *Wabanaki* representatives. A suitable person, a member of the bereaved tribe, was chosen by acclamation for the office of chief. If there was no objection to him a new flag-pole was made and prepared for raising, and a chief from one of the kindred tribes put a medal of wampum on the chief-elect who was always clothed in new garments. The installing chief then addressed the people, telling them that another "eldest boy" had been chosen, to whom they owed implicit obedience. Turning to the new chief, he informed him that he must act in accordance with the wishes of his people. The main duties of a chief were to act as arbiter in all matters of dispute, and to act as commander-in-chief in case of war, being ready to sacrifice himself for the people's good if need were.

After this ceremony they marched to the hall, where another dance took place, the new chief singing and beating the drum. A wife of one of the other chiefs then placed a new deer-skin or bear-skin on the shoulders of the new chief as a symbol of his authority, after which the dance continued the whole night.

The officers of the new chief (*geptins*) were still to be chosen. These were seven in number and were appointed in the same manner and with the same ceremonies as the chief. Their duties, which were much more severe, were told them by the installing chief. The flag-pole, which was the symbol of the chief, was first raised. The *geptins* stood around it, each with a brush in his hand, with which they were instructed to brush off any particle of dust that might come upon it. This signified that it was their duty to defend and guard their chief and that they should be obliged to spill their blood for him, in case of need and in defense of the

W'tachwi lipoonmenia opokenoom ya hotankeyowa tich-hi nihitanke yatgotachihi tan etuchi nesa naguak pechyamkotit. Chewi noteyik gaptinek wut sagem kislomot katama kiseltumwawun wichipnusin ansa teppo w'tankeyowa opemowsowinoom naga w'note genekmen tan gekw-nesanaguak pechiyak. Nitt wut sagem naga otelitepsowinoom okisitpesotinia.

Nitt apch ketkil elok-h'dimkil malem te nitt welaguiwik nitt yaka opemkanya tegio te apch echeguak enitespatek w'tenkamhedoltinia. Enowdoltowuk epeskum-h'dinya w'kisik-apwelanya metewagwemel. Nitt m'sioo tan elitowtoltitit ek-hodasik tan wut neglo-wechik niktech wikw-nekik niltelkisek hodasikil. Nitt elok-h'dim'k anquoch queneket nihi sente kessena te pes-kisoos.

Nibowe eldakewag'n n'kansoswei.

Tan etuchi w'skinoos pewatek oniswitijil en w'takin-wetowan w'nikigo naga tan yot'l pawatgil nika nio nitaskowtitiesil netch wut k'takw-hemoos w'takin-wetuwan w'telnapem nitt skawen waplit-hodmuk nittech tekw-chetunia. Nitt wut k'takw-k'moosimilan kelwasilipil pileyal mowinewiyul kessena odook kessena quabitewiyul. Nutch wut oskinoos omachep-hon odeneksonel yet nackskw wikowak netch nitponan wut neksonel nowtek wigwamek; yote ebonel nisnol naga nowtek naga k'soshone. Nitt elichpi milipitasik ela-wigwam nitt kisekelat w'doneksonel. Wut loo nackskw omitakwsel otakin-wetuwan otelnapem malem te kisi mowemat w'nustowan eliwisilit w'skinosel pechipowat matonijanel w'niswinya. Nitt skawen wablitt-hodmuk nittech wut kitakw-p'moos w'telkiman w'tusel nowtek pemekpit eneksone nittech nitt kisitt piye nipwoltin nitan elikwusitasik wigopaltin mawemitsoltin ayot pemkamik neskow h'dim'k. Anquotch quenatk't pemlokemkil.

Nibowe eldakewag'n yote pilioo yot kisi mawetasik.

Tan etuchi w'skinoos ketwakatek w'tachwich na kinwettwa w'nikiko w'nostowan nackskwyil powatkil. Netch wut k'takw-hemoos omaweman w'telnapemwa nitt skatwen waplit-hodmuk. Nitch w'dakinwettowania nojikelol welijil nitch omacheptunia nequotatkeyi wapap nittech nitt milatit wut nackwesk omitakw-sel naga tan te kisikesitit kesosejihi najichik lutkig wapap egitasik nibowei. Liwitasso k'lelwewei yotech w'tetlegitm'n elgitnuwik w'nestowalch na eli-wisilit

tribe. All the women and children and disabled persons in the tribe were under the care of the *geptins*. The chief himself was not allowed to go into battle, but was expected to stay with his people and to give orders in time of danger.

After the tribal officers had been appointed, the greatest festivities were carried on; during the day they had canoe races, foot races and ball-playing, and during the night, feasting and dancing. The Indians would bet on the various sports, hanging the prizes for each game on a pole. It was understood that the winner of the game was entitled to all the valuables hung on this pole. The festivities often lasted an entire month.

The Marriage Ceremony.

The Ancient Rite.

It was the duty of the young Indian man who wished to marry to inform his parents of his desire, stating the name of the maiden. The young man's father then notified all the relatives and friends of the family that his son wished to marry such and such a girl. If the friends and relations were willing, the son was permitted to offer his suit. The father of the youth prepared a clean skin of the bear, beaver or deer, which he presented to his son. Provided with this, the suitor went to the wigwam of his prospective bride's father and placed the hide at the back of the wigwam or *nowteh*. The girl's father then notified his relations and friends, and if there was no objection, he ordered his daughter to seat herself on the skin, as a sign that the young man's suit was acceptable. The usual wedding ceremonies were then held, viz., a public feast, followed by dancing and singing, which always lasted at least a week.

The Marriage Ceremony in Later Days.

After the adoption of the wampum laws the marriage ceremony was much more complicated.[1]

When the young man had informed his parents of his desire to marry and the father had secured the consent of the relations and friends, an Indian was appointed to be the *Keloolwett* or marriage herald, who, taking the string of wampum called the *kelolwawei*,

[1] Mitchell interpolated this remark.

oskinosel n't pawatek nit'l nackskwuyil oniswinya. Nittech nitt metewestakw nittech weswi yapasinia yot w'skinoos wigek. Nittec-et-tlaskowasooltitit tegio asittemoot. Nittech na wut nackskw omitakw-sel omaweman otelnapemw'l nittech skatwen wablit-hamagw nit'l pechi kelolwelijil nittlowen kegw k'chi chitwat ewabligik w'mestom'nch. Nittech sagesso k'tinipwooltimkepn. Nittlo m'sioo li wulit-hodmotit nitt etepkisitpiye. Nitt neke oskichinwuk kisi papatmotit nitch patlias onipwik-han.

Nittech nitt'l nibowe eldakewag'n'l elok h'dim. Wutech w'skinoos omilwan pileyal elquootewag'n'l nitt kissewett wut pilkatek netch omach yapasinia oniswitijil wigwek netch w'natlasikwan w'niswitijil wenachi sekeptinenan w'niswitijil naga kesosejihi. Yot nitt eliwittasik eldakewag'n wulisakowdawag'n. Nitt weswesitt wikwak nutch nut holpiyanya yohot na pechi kesosejihi quesquesoos naga pilskwessis naga gana w'skittapyik. Wutech na w'skinoos na onag'nl ma keslasikasijihi nittech omach yapasinia w'nachi sekeptinenya. Malem tech metlasikowdoltin. Nittech uletonya k'chi mawepoltimek wutech nackskw towipootpoonek liwitass natpoonan oskittapyik epijik pechi te wasisek. Wutech na w'skinoos soksagw kotch meketch tlagw-te mijwag'n malemch kisakw-tek. Nitt wiko-paltinya netch w'gagalwaltinya k'waltewall. M'sitte wen w'nestem nitt.

Nitt omache guaskoltinia natchi teppam wan wikopalan. Mechte nibowattimek meskw metekto. Nitte otlas-hewhodlusooltinya naga omach yapasinia gwandowanek. Malem te pachaswook gwando-wanek pechi kesosejihi. Nitte kes yapasitit nitte pesgowat peskutenil ech wechi k'chich yot lusoweskw eliyit kis gwandowanek. Nitt ne oskinoo-lusoo. Ena negum omach yapasinia kesooswechihi malem te petapaswuk kesyapasittit nitt apch peskw-tay peskowat. Nitte gaptin omachep-han omachi-ostook kegania oniswitijil.

Malem te epasitpokak en-onatpoon-h'dinya kiste wulaquipwag'n. Nitt etli mikomoot yotk kisiniswijik nitt yot'l lusowesquiwil omache kesoosanya k'chi epitjik. Otasohonel na onespiptonial.

Metegut.

went to the wigwam of the girl's father, generally accompanied by as many witnesses as cared to attend. The herald read the marriage wampum in the presence of the girl and her father, formally stating that such and such a suitor sought his daughter's hand in marriage. The herald, accompanied by his party, then returned to the young man's wigwam to await the reply. After the girl's father had notified his relatives and friends and they had given their consent, the wedding was permitted to go on.

The usual ceremonies then followed. The young man first presented the bride-elect with a new dress. She, after putting it on, went to her suitor's wigwam with her female friends, where she and her company formally saluted him by shaking hands. This was called *wulisakowdowagon* or salutation. She then returned to her father's house, where she seated herself with her following of old women and girls. The groom then assembled a company of his friends, old and young men, and went with them to the bride's wigwam to salute her in the same manner. When these salutations were over a great feast was prepared by the bride, enough for all the people, men, women and children. The bridegroom also prepared a similar feast. Both of these dinners were cooked in the open air and when the food was ready they cried out *k'waltewall* "your dishes." Every one understood this, which was the signal for the merry-makers to approach and fall to.

The marriage ceremonies, however, were not over yet. The wedding party arrayed themselves in their best attire and formed two processions, that of the bride entering the assembly wigwam first. In later times it was customary to fire a gun at this point as a signal that the bride was in the hall, whereupon the groom's procession entered the hall in the same manner, when a second gun was fired. The *geptins* of the tribe and one of the friends of the bride then conducted the girl to the bridegroom to dance with him. At midnight after the dancing a supper was served, to which the bride and groom went together and where she ate with him for the first time. The couple were then addressed by an aged man (*noimikokemit*) on the duties of marriage.

Finally, a number of old women accompanied the newly made wife to her husband's wigwam, carrying with them her bed-clothes. This final ceremony was called *natboonan*, taking or carrying the bed.

The End.

THE ETHNIC AFFINITIES OF THE GUETARES OF COSTA RICA.

BY DANIEL G. BRINTON, M.D.

(*Read December 3, 1897*).

The Guetares, or Huetares, of Costa Rica, included various tribes speaking related dialects now believed to be wholly extinct. They dwelt on the lofty plateau of the interior, in the vicinity of Cartago and San José de Costa Rica, and for that reason received their name from their Nahuatl neighbors, which is a corruption of the Nahuatl *uei tlalli*, great land (Peralta).

They were a people of no mean culture, as the fine examples of worked gold ornaments and deftly carved stones obtained from their sepulchres and exhibited at the Madrid and Chicago exhibitions testify. Many of the best specimens now in the Museum of Costa Rica were collected from these interments by the director, Señor Anastasio Alfaro.

These remains justify the description of Juan Vasquez de Coronado, who was among them in 1562. He depicts them as of active intelligence, war-like in disposition, tall and well built, wearing cotton clothes skillfully woven, and having in their possession much gold. From other sources we learn that they were celebrated among the surrounding nations for their *mitotes*, sacred songs and dances; and that they were accustomed to make human sacrifices at the burial of important individuals.[1]

But where the Guetares belonged in the linguistic classification of American tribes has up to the present been an unsolved problem.

Writing in 1890, M. Alphonse Pinart asks: "In Costa Rica, those tribes called Guetares, who dwelt at first on the southern declivity of the Sierra and were driven thence by the invading Nahuas, were they not related to the Carib family of the southern continent?"[2] And in 1893, Manuel de Peralta, in his excellent study of Costa Rican ethnography, observes, "It is almost impossible to ascertain the ethnic affinities of the Guetares, since no vocabulary of their language has been found; but archæology shows that if they

[1] See M. de Peralta, *Costa Rica, Nicaragua y Panama en el Siglo xvi*, pp. 762, 770 (Madrid, 1883).

[2] Pinart, *Limite des Civilizations dans l'Isthme Americain* (Paris, 1890).

were not actually related to the Nahuas, they were at least under their cultural influence."[1]

These two guesses, so widely asunder, by eminent living authorities, indicate how uncertain ethnographers are as to the relationship of this once important and cultured people.

This uncertainty I shall endeavor to dispel by an examination of a few words preserved by early writers supposed to be in the Guetar language; by a comparison of some proper names stated to be from their tongue; and by the aid of an unpublished vocabulary obtained from what was believed to be the last remnant of the tribes, about forty years ago.

The traveler Benzoni visited the area of Costa Rica in 1528, and gives the following five words of the language of the "Suerra" (to be pronounced according to the Italian alphabet):[2]

Earth, *ischa.*
Men, *cici.*
Sickness, *stasa.*
Gold, *chiaruela.*
Great, *matto.*
A wild animal, *cascuii.*

These words mostly belong without doubt to the Talamancan linguistic substock. Thus, *ischia* = Talamanca *ischiko*, earth, and Cabecar *hizhku.* The word for men, *cici*, is the Cabecar, *jiji;* that for gold, *chiaruela*, appears a modification of the Talamanca *txela*, copper, perhaps yellow metal. The word for large, *matto*, belongs probably to the Cuna, which has *tumati;* and *cascuii* has too vague a meaning to identity. The term *stasa* for sickness does not appear in modern vocabularies.

But the "Suerre," although assumed by Dr. Berendt and others as identical with the Guetar tongue, is not positively known to be so; and geographically it appears to have been on the north coast along the river of the same name, some distance from the province of the historical Guetares.

I have found but one word of the ancient Guetar language preserved by the early conquistadores, but it is almost convincing of their linguistic position. This is *ueritecas* or *biritecas*, applied by them to the women of the neighboring province of Coto, because they went forth to battle with the men and joined like them in

[1] Translated in my *Report upon the collections exhibited at the Columbian Historical Exposition, Madrid*, p. 40, *sq.* (Washington, 1895).

[2] Benzoni, *Historia del Mondo Nuovo*, fol. 77 (Venice, 1572).

the fray.[1] This is clearly in the Talamancan tongue compounded of *era* or *wa-re*, woman, and probably *ituk*, to shoot, chop or strike.[2]

To this evidence may be added that of some geographical names. It is considered by local antiquaries that the names of several mountains in the region referred to belong to the extinct Guetar dialect. Examples of these are Excasu, Atarazu and Irazu. Here the termination *zu* cannot be else than the Cabecar *tsu* (Gabb), meaning hill or mountain.

Finally, I have a vocabulary taken at least forty years ago from some natives surviving near San José de Costa Rica, in the ancient Guetar territory. It is called Talamanca, but Mr. Gabb, who saw it, pronounced it to be of a different dialect; and Dr. Berendt, from whose collection it came, marked it as "antigua Talamanca." I believe it to be the only specimen of the Guetar dialect known, and as such I quote from it the list of words I used in my *American Race*, adding their similars in some other dialects of the stock.

VOCABULARY OF "ANCIENT TALAMANCA" OR GUETAR.

Man,	*pejelilli*	(Cabecar,	*pejettillè* = vir).
Woman,	*palacrak*	(*id.*,	*palacrak*).
Sun,	*cagune*	(*id.*,	*cagune*).
Moon,	*furia*	(*id.*,	*tura*).
Fire,	*yocò*	(*id.*,	*yocó*).
Water,	*dicre*	(*id.*,	*dicre*).
Head,	*sotacii*	(*id.*,	*sotacu*).
Eye,	*seguebra*	(*id.*,	*seguebra*, or *wobra*, Gabb)
Ear,	*secuque*	(*zgo-ku*,	Gabb).
Mouth,	*sequeque*	(*ko-kwu*,	*id.*).
Nose,	*seyiquete*	(*jīk*,	*id.*).
Tongue,	*seguecte*	(*kok-tu*,	*id.*).
Tooth,	*saka*	(*ka*,	*id.*).
Hand,	*seyura*	(*ura*,	*id.*).
Foot,	*ecuru*	(*kru-kwe*,	*id.*).
House,	*tu*	(*hu*,	*id.*).

This comparison leaves no room for doubt that this modern dialect, supposed to represent the ancient Guetar, is Talamancan, and closely allied to the Cabecar still spoken in Costa Rica; and from all the evidence above brought forward, the identification of the Guetares as a branch of the Talamancan linguistic group is sufficiently conclusive.

[1] Juan Vazquez de Coronado, in Peralta, U. S., p. 775.

[2] Gabb, *Indian Tribes and Languages of Costa Rica*, p. 533.

Stated Meeting, December 17, 1897.

Vice-President PEPPER in the Chair.

Present, 35 members.

Messrs. James S. deBenneville and Charles R. Hildeburn, newly elected members, were presented to the Chair and took their seats in the Society.

Acknowledgments of election to membership were received from Hon. Thomas F. Bayard and Prof. Frank Morley.

The Finance Committee presented a report and recommended the appropriations for the year, which were approved and ordered.

Prof. Morris Jastrow, Jr., made a communication on "The Original Character of the Jewish Sabbath."

Pending nominations were read and spoken to, and the Society proceeded to the election of new members, after which the Tellers reported that the following persons had been elected members:

2352. T. J. J. See, A.M., Ph.D. (Berlin), Flagstaff, Ariz.
2353. Sydney George Fisher, Philadelphia.
2354. Hon. Richard Olney, Boston.
2355. Edward S. Holden, Lick Observatory, Cal.
2356. Benjamin Kendall Emerson, Amherst.
2357. Rev. Francis L. Patton, D.D., LL.D., Princeton.
2358. Alden Sampson, Haverford, Pa.
2359. Ethelbert D. Warfield, Easton.
2360. Charles De Garmo, Swarthmore.
2361. William H. Dale, Washington.
2362. Arnold E. Ortmann, Ph.D., Princeton.
2363. Leroy W. McCay, D.Sc., Princeton.
2364. Henry B. Fine, Ph.D., Princeton.
2365. John B. Hatcher, Ph.D., Princeton.
2366. Charles F. W. McClure, M.A., Princeton.

The Society was adjourned by the presiding officer.

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LIST OF MEMBERS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY.

FEBRUARY 12, 1898.

A

	Name.	*Date of Election.*	*Present Address.*
1687.	ABBE, CLEVELAND, Professor . .	July 27, 1871,	U. S. Weather Bureau, Washington, D. C.
2170.	ABBOT, DR. CHARLES CONRAD . .	Dec. 20, 1889,	Trenton, N. J.
1463.	ABBOT, GEN. HENRY L.	April 18, 1862,	23 Berkeley Street, Cambridge, Mass.
2311.	ABBOTT, ALEXANDER C., M.D. . .	Feb'y 19, 1897,	221 S. 44th Street, Philadelphia.
1809.	ÅCKERMAN, RICHARD, Professor.	July 21, 1876,	Stockholm, Sweden.
1713.	ACLAND, SIR HENRY, Bart. . . .	Jan'y 17, 1873,	Oxford, England.
2128.	ADAM, LUCIEN.	Dec. 17, 1886,	41 Bard Sevigné, Rennes, France.
2081.	ADAMS, HERBERT B., Professor. .	May 21, 1886,	Baltimore, Md.
1779.	AGASSIZ, ALEXANDER, Professor .	April 16, 1875,	Cambridge, Mass.
1642.	AGASSIZ, MRS. ELIZABETH	Oct. 15, 1869,	Quincy St., Cambridge, Mass.
1860.	ALISON, DR. ROBERT HENRY. . .	May 3, 1878,	Ardmore, Montgomery Co., Pa
1869.	ALLEN, JOEL ASAPH	Sept. 20, 1878,	Am. Mus. Natural History, 77th St. and 8th Ave., New York.
1927.	AMES, REV. CHARLES G.	Jan'y 21, 1881,	12 Chestnut St., Boston, Mass.
2064.	ANDERSON, GEORGE B., Lieut. .	Feb'y 19, 1886,	West Point, N. Y.
2164.	ANGELL, JAMES B., Pres't. . . .	Oct. 18, 1889,	Ann Arbor, Mich.
2224.	APPLETON, WILLIAM HYDE, Prof.	May 19, 1893,	Swarthmore, Pa.
2102.	ARGYLL, DUKE OF.	May 21, 1886,	London, England.
1761.	ARMSTRONG, THE RIGHT HON. LORD	July 17, 1874,	Cragside, Rothbury, England.
1996.	ASHHURST, JOHN, JR., M.D. . . .	Jan'y 18, 1884,	2000 Delancey Pl., Phila.
2012.	ASHHURST, RICHARD L.	April 18, 1884,	2204 Walnut St., Philadelphia.

B

	Name.	*Date of Election.*	*Present Address.*
1995.	BACHE, R. MEADE.	Jan'y 18, 1884,	4400 Sansom St., Philadelphia.
1832.	BACHE, DR. THOMAS HEWSON .	Feb'y 2, 1877,	233 S. 13th St., Philadelphia.
2285.	BAILEY, L. H., Professor. . . .	May 15, 1896,	Cornell Univ., Ithaca, N. Y.
1630.	BAIRD, HENRY CAREY	Jan'y 15, 1869,	810 Walnut St., Philadelphia.
1991.	BAIRD, HENRY M., Professor . .	Jan'y 18, 1884,	219 Palisade Ave., Yonkers, N.Y.
2345.	BALDWIN, JAMES MARK, Prof. . .	Oct. 15, 1897,	Princeton, N. J.
2191.	BALL, SIR ROBERT STAWELL . .	May 15, 1891,	Observatory, Cambridge, Eng.
1965.	DEBAR, HON. EDOUARD SÈVE . .	July 21, 1882,	Ramsgate, England.
1818.	BARCENA, DON MARIANO, Prof.	Feb'y 2, 1877,	Museo Nacional, Mexico.
1741.	BARKER, GEORGE F., Professor . .	April 18, 1873,	3909 Locust St., Philadelphia.
2011.	BARKER, WHARTON	April 18, 1884,	119 S. 4th St., Philadelphia.
1902.	BARTHOLOW, ROBERTS, M.D. . .	April 16, 1880,	1525 Locust St., Philadelphia.
2119.	BASTIAN, ADOLPH, Professor . . .	Dec. 17, 1886,	S. W. Königgrätzerstrasse 120, Berlin, Germany.
2337.	BAYARD, HON. THOMAS F.	Oct. 15, 1897,	Wilmington, Del.
1934.	BEAULIEU, M. PAUL LEROY, Prof.	April 15, 1881,	No. 27 Ave. du Bois de Boulogne, Paris, France.
1968.	BELL, ALEXANDER GRAHAM, Prof.	July 21, 1882,	1336 19th St., Washington, D.C.
1802.	BELL, SIR LOWTHIAN	April 21, 1876,	Northallerton, England.
2255.	BEMENT, CLARENCE S.	May 17, 1895,	1804 Spring Garden St., Phila.
2326.	DEBENNEVILLE, JAMES S	Oct. 15, 1897,	123 S. 7th Street, Philadelphia.
2264.	BERTHELOT, M. P. E. MARCELIN .	May 17, 1895,	Paris, France.
2253.	BERTIN, GEORGES	May 17, 1895,	11 bis Rue Ballu, Paris.
2228.	BESSEMER, SIR HENRY	Feb'y 16, 1894,	Surrey, England.
2149.	BIDDLE, ALEXANDER	Feb'y 17, 1888,	1307 Walnut St., Philadelphia.
1920.	BIDDLE, CADWALADER	Oct. 15, 1880,	1420 Walnut St., Philadelphia.
1831.	BIDDLE, HON. CRAIG	Feb'y 2, 1877,	2033 Pine Street, Philadelphia.
2134.	BILLINGS, JOHN S., M.D.	Feb'y 18, 1887,	40 Lafayette Place, New York.
2256.	BISPHAM, GEORGE TUCKER . . .	May 17, 1895,	1805 Delancey Place, Phila.
2157.	BLAIR, ANDREW A.	May 17, 1889,	406 Locust Street, Philadelphia.
1554.	BLAIR, THOMAS S.	Jan'y 19, 1866,	P. O. Box 508, Tyrone, Pa.
1669.	BLAKE, WM. PHIPPS, Professor .	Oct. 21, 1870,	New Haven, Conn.
1700.	BLODGET, LORIN	April 19, 1872,	1329 S. Broad St., Philadelphia.
1444.	BÖHTLINGK, M. OTTO	Jan'y 17, 1862,	Seeburgstrasse 35, II, Leipzig.
2235.	BONAPARTE, PRINCE ROLAND . .	Feb'y 15, 1895,	10 Ave. d' Jena 22, Paris.
2047.	BONWILL, W. G. A., D.D.S. . . .	Oct. 16, 1885,	2009 Chestnut St., Philadelphia.
1126.	BOYÉ, MARTIN H., Professor . .	Jan'y 17, 1840,	Coopersburg, Lehigh Co., Pa.
1826.	BRACKETT, CYRUS FOGG, Professor	Feb'y 2, 1877,	Princeton, N. J.
2083.	BRANNER, JOHN C., Professor . .	May 21, 1886,	Stanford Univ., Palo Alto, Cal.
2195.	BREZINA, DR. ARISTIDES.	May 21, 1886,	VII Siebensterngasse, 46, Vienna, Austria.
1636.	BRINTON, DANIEL G., M.D. . . .	April 16, 1869,	Media, Delaware Co., Pa.
2069.	BRINTON, JOHN H., M.D	Feb'y 19, 1886,	1423 Spruce St., Philadelphia.
1745.	BRINTON, J. BLODGET	Oct. 17, 1873,	339 Walnut St., Philadelphia.
2080.	BROOKS, WILLIAM KEITH, Prof. .	May 21, 1886,	Johns Hopkins Univ., Baltimore, Md.
1881.	BROWN, ARTHUR ERWIN	April 18, 1879,	1208 Locust St., Philadelphia.
2275.	BRUBAKER, ALBERT P., M.D. . .	Oct. 18, 1895,	105 N. 34th St., Philadelphia.
1547.	BRUSH, GEORGE J., Professor . .	Jan'y 20, 1865,	Yale University, New Haven, Conn.
2236.	BUDGE, DR. A. WALLIS.	Feb'y 15, 1895,	British Museum, London, Eng.
1653.	BULLOCK, CHARLES	Oct. 15, 1869,	1017 Clinton St., Philadelphia.
1452.	BUNSEN, ROBERT W., Professor .	Jan'y 17, 1862,	Heidelberg, Germany.
2007.	BURK, REV. JESSE Y	Jan'y 18, 1884,	400 Chestnut St., Philadelphia.

C

	Name.	*Date of Election.*	*Present Address.*
1938.	BUTLER, HON. WILLIAM	April 15, 1881,	West Chester, Pa.
1788.	CAMPBELL, JOHN LYLE, Prof. . .	July 16, 1875,	Crawfordsville, Ind.
1606.	CANBY, WILLIAM MARRIOTT . . .	Oct. 16, 1868,	1101 Delaware Avenue, Wilmington, Del.
2051.	CANNIZZARO, TOMASO	Oct. 16, 1885,	Santa Maria fuori cinta, Casa Roffa, Messina, Sicily.
1731.	CAPELLINI, GIOVANNI, Senator .	April 18, 1873,	Portovenere près Spezia, Italy.
1796.	CARLL, JOHN F., Professor	Oct. 15, 1875,	Pleasantville, Venango Co., Pa.
1911.	CARSON, HAMPTON L.	April 16, 1880,	1033 Spruce St., Phila.
2260.	CARTER, HON. JAMES C	May 17, 1895,	54 Wall Street, New York City.
1707.	CASSATT, ALEXANDER J	Oct. 18, 1872,	Haverford, Del. Co., Pa.
2147.	CASTNER, SAMUEL, JR.	Dec. 16, 1887,	3729 Chestnut St., Philadelphia.
2152.	CATTELL, DR. J. MCKEEN	May 18, 1888,	Garrison-on-Hudson, N. Y.
1908.	CHANCE, DR. HENRY MARTYN. .	April 16, 1880,	5164 Columbia Ave., Phila.
1783.	CHANDLER, C. F., Professor .	April 16, 1875,	49th St., cor. 4th Av., N.Y. City.
1778.	CHAPMAN, HENRY C., M.D. . . .	April 16, 1875,	2047 Walnut St., Philadelphia.
2132.	DE CHARENCEY, COMTE HYACINTH	Dec. 17, 1886,	25 rue Barbet de Jouy, Paris.
2158.	CLARK, CLARENCE H.	May 17, 1889,	42d and Locust Sts., Phila.
1717.	CLARKE, THOMAS C. E	Jan'y 17, 1873,	44 Broadway, New York, N. Y.
1983.	CLAYPOLE, E. W., Professor . . .	Jan'y 19, 1883,	Buchtell College, Akron, O.
2247.	CLEEMAN, RICHARD A., M.D. . . .	Feb'y 15, 1895,	2135 Spruce St., Philadelphia.
2336.	CLEVELAND, HON. GROVER, . . .	Oct. 15, 1897,	Westland, Princeton, N. J.
1999.	COHEN, J. SOLIS, M.D.	Jan'y 18, 1884,	1341 Walnut St., Philadelphia.
2305.	CONKLIN, EDWIN GRANT, Prof. .	Feb'y 19, 1897,	University of Penna., Phila.
2257.	COOK, JOEL	May 17, 1895,	849 N. Broad St., Philadelphia.
2129.	CORA, GUIDO, Professor	Dec. 17, 1886,	Corso Vittorio Emanuele, 74, Turin, Italy.
1867.	COUES, ELLIOTT, M.D., U. S. A. .	Sept. 20, 1878,	Washington, D. C.
1662.	COX, HON. JACOB D.	April 15, 1870,	Cincinnati, O.
2207.	CRAMP, CHARLES H	Dec. 16, 1892,	507 S. Broad St., Philadelphia.
1836.	CRANE, THOMAS FREDERICK, Prof.	Feb'y 2, 1877,	Cornell Univ., Ithaca, N. Y.
2317.	CULIN, STEWART	May 21, 1897,	University of Penna , Phila.
2100.	CROOKES, WILLIAM, Professor . .	May 21, 1886,	7 Kensington Park Gardens, London, W. England.
2172.	CRUZ, HON. FERNANDO, M.D. . .	Dec. 20, 1889,	Washington, D. C.
1439.	CURWEN, JOHN, M.D.	April 18, 1861,	Warren, Pa.
2296.	CUSHING, FRANK H.	May 15, 1896,	Bureau of Ethnology, Washington, D. C.

D

1567.	DA COSTA, J. M., M.D	Oct. 19, 1866,	1700 Walnut St., Philadelphia.
2361.	DALL, WILLIAM H.	Dec. 17, 1897,	U. S. National Museum Washington, D. C.
2214.	DALY, HON. CHARLES P.	May 19, 1893,	11 W. 29th St., New York, N. Y.
2282.	DANA, EDW. S., Professor	May 15, 1896,	Yale Univ., New Haven, Conn.
1806.	DANNEFELD, C. JUHLIN	April 21, 1876,	27 Gt. Winchester St., London.
1811.	DAVENPORT, SAMUEL.	Oct. 20, 1876,	Adelaide, S. Australia.
1557.	DAVIDSON, GEORGE.	Jan'y 19, 1866,	Observatory, San Francisco, Cal.
1923.	DAWKINS, WM. BOYD, Prof. . . .	Oct. 15, 1880,	Woodhurst, Fallowfield, Manchester, England.
2360.	DE GARMO, CHARLES, President.	Dec. 17, 1897,	Swarthmore, Pa.
2208.	DERCUM, FRANCIS X., M.D. . .	Dec. 16, 1892,	1719 Walnut St., Philadelphia.
2013.	DICKSON, SAMUEL	April 18, 1884,	901 Clinton St., Philadelphia.

	Name.	*Date of Election.*	*Present Address.*
2208.	DIXON, SAMUEL G., M.D	Dec. 16, 1892,	Academy of Natural Sciences, Philadelphia.
2108.	DOLLEY, CHARLES S., M.D. . . .	Dec. 17, 1886,	3707 Woodland Ave., Phila.
2089.	DONNER, DR. OTTO.	May 21, 1886,	Helsingfors, Finland.
1946.	DOOLITTLE, C. L., Professor . . .	Oct. 21, 1881,	College Hall, Univ. of Penna.
1839.	DOUGLAS, JAMES	April 20, 1877,	Spuytenduyvil, NewYork, N.Y.
1924.	DRAPER, DANIEL.	Oct. 15, 1880,	Meteorological Observ., Central Park, New York, N. Y.
2303.	DREER, FERDINAND J.	Feb'y 19, 1897,	1520 Spruce St., Philadelphia.
1787.	DROWN, THOMAS M., President .	July 16, 1875,	Lehigh Univ., S. Bethlehem, Pa.
1918.	DU BOIS, PATTERSON	Oct. 15, 1880,	1031 Walnut St., Philadelphia.
1878.	DUDLEY, CHARLES BENJAMIN . .	Jan'y 17, 1879,	Altoona, Blair Co., Pa.
2063.	DUNCAN, LOUIS, U. S. N.	Feb'y 19, 1886,	Johns Hopkins Univ., Balt., Md.
1573.	DUNNING, GEORGE F.	Jan'y 18, 1867,	Farmington, Conn.
1727.	DUPONT, EDOUARD	April 18, 1873,	Musée Royal Museum, Bruxelles, Belgium.
2227.	DUPONT, COL. HENRY A	Feb'y 16, 1894,	Winterthur, Montchanen, Del.
1679.	DUTTON, CLARENCE E., Lieut. U.S.A	Jan'y 20, 1871,	U. S. Arsenal, Washington, D.C.

E

2105.	EASTON, MORTON W., Professor .	Dec. 17, 1886,	224 S. 43d St., Philadelphia.
2271.	EBERS, DR. GEORGE	May 17, 1895,	Tutzing, near Munich, Bavaria.
1917.	ECKFELDT, JACOB B	Oct. 15, 1880,	U. S. Mint, Philadelphia.
1825.	EDDY, H. TURNER, Professor. . .	Feb'y 2, 1877,	Univ. Minn., Minneapolis.
2294.	EDISON, THOMAS A.	May 15, 1896,	Orange, N. J.
2262.	EDMUNDS, HON. GEORGE F . . .	May 17, 1895,	1724 Spruce St., Philadelphia.
1686.	ELIOT, DR. CHARLES W.	April 21, 1871,	17 Quincy St., Cambridge, Mass.
2272.	ELLIOTT, A. MARSHALL, Professor	May 17, 1895,	Baltimore, Md.
2313.	ELY, THEODORE N.	May 21, 1897,	Broad St. Station, Phila.
2356.	EMERSON, BENJ. KENDALL, Prof.	Dec. 17, 1897,	Amherst, Mass.
1981.	EMMONS, S. F.	Jan'y 19, 1883,	U. S. Geological Survey, Washington, D. C.
1943.	EVANS, SIR JOHN, K.C.B.	Oct. 21, 1881,	Nash Mills, Hemel Hempstead, England.
2254.	EWELL, MARSHALL D., M.D . . .	May 17, 1895,	59 Clark St., Chicago, Ill.

F

2234.	FENNELL, C. A. M., Litt.D. . . .	Feb'y 15, 1895,	Cambridge, England.
2180.	FIELD, ROBERT PATTERSON . . .	May 16, 1890,	218 S. 42d St., Philadelphia.
2364.	FINE, HENRY B., Professor . . .	Dec. 17, 1897,	Princeton, N. J.
2353.	FISHER, SYDNEY GEORGE	Dec. 17, 1897,	328 Chestnut St., Philadelphia.
1901.	FLINT, AUSTIN, JR., M.D.	April 16, 1880,	14 W. 33d St., New York, N. Y.
1621.	FLOWER, WM. HENRY, M.D. . . .	Jan'y 15, 1869,	South Kensington Museum, London, England.
1875.	FOGGO, EDWARD A., D.D.	Oct. 18, 1878,	3216 Summer St., Philadelphia.
2197.	FORBES, GEORGE, Professor. . . .	Oct. 16, 1891,	34 Great George St., London, England.
1170.	FRALEY, HON. FREDERICK . . .	July 15, 1842,	2017 Delancey Place, Phila.
1912.	FRALEY, JOSEPH C.	April 16, 1880,	714 Walnut St., Philadelphia.
2270.	FRANKS, SIR AUGUSTUS W. . . .	May 17, 1895,	123 Victoria St., S. W. London, England.
1695.	FRAZER, PERSIFOR, Dr. ès-Sc. Nat.	Jan'y 19, 1872,	928 Spruce St., Philadelphia.
301.	FRAZIER, BENJ. W., Professor . .	Dec. 18, 1896,	Lehigh Univ., Bethlehem, Pa.

	Name.	*Date of Election.*	*Present Address.*
2171.	FRIEBIS, GEORGE, M.D.	Dec. 20, 1889,	1906 Chestnut St., Philadelphia.
2179.	FULLERTON, GEORGE S., Rev. . .	May 16, 1890,	309 S. 40th St., W. Philadelphia.
1739.	FULTON, JOHN	April 18, 1873,	136 Park Pl., Johnstown, Pa.
1914.	FURNESS, HORACE H.	April 16, 1880,	Wallingford, Delaware Co., Pa.
2306.	FURNESS, HORACE HOWARD, JR..	Feb'y 19, 1897,	2034 Delancey Place, Phila.
2304.	FURNESS, WILLIAM H., 3d, M.D. .	Feb'y 19, 1897,	Wallingford, Del. Co., Pa.

G

1988.	GARRETT, PHILIP C	April 20, 1883,	Logan P. O., Philadelphia.
2079.	GATES, MERRILL E., Dr	May 21, 1886,	Amherst, Mass.
1025.	GATSCHET, ALBERT S., Dr	Oct. 17, 1884,	1330 F St., N. W., Wash'n, D. C.
1897.	GEIKIE, SIR ARCHIBALD	Jan'y 16, 1880,	Geological Survey Office, 28 Jermyn St., London, England.
1803.	GEIKIE, JAMES, Professor	April 21, 1876,	31 Merchiston Ave., Edinburgh. Scotland.
2067.	GENTH, F. A., JR	Feb'y 19, 1886,	103 N. Front St., Philadelphia.
2274.	GIBBS, J. WILLARD, Professor . .	May 17, 1895,	121 High St., New Haven, Conn.
1355.	GIBBS, OLIVER WOLCOTT, Prof. .	July 21, 1854,	Newport, R. I.
1587.	GILL, THEODORE N., M.D.	July 19, 1867,	Smithsonian Inst., Wash'n, D.C.
1800.	GILMAN, DR. DANIEL C.	April 21, 1876,	25 N. Charles St., Baltimore, Md.
1950.	GLADSTONE, RT. HON. WM. EWART	Oct. 21, 1881,	Hawarden, England.
2240.	GLAISHER, JAMES W. L.	Feb'y 19, 1895,	The Shola, Heathfield Road, South Croydon, England.
2233.	GLAZEBROOK, RICHARD T	Feb'y 15, 1895,	Cambridge, England.
2212.	GOODALE, GEORGE LINCOLN, Prof.	Feb. 17, 1893,	Harv. Univ., Cambridge, Mass.
1680.	GOODFELLOW, EDWARD	Jan'y 20, 1871,	1718 Corcoran St., Washington, D. C.
2292.	GOODSPEED, ARTHUR W., Prof.	May 15, 1896,	Univ. of Pa. College Building, Philadelphia.
2203.	GOODWIN, HAROLD.	May 20, 1892,	501 Walnut St., Philadelphia.
2232.	GOODWIN, W. W., Professor . . .	Feb'y 15, 1895,	Cambridge, Mass.
1851.	GRAY, ELISHA.	Jan'y 18, 1878,	220 Kinzie St., Chicago, Ill.
2222.	GREEN, SAMUEL A., M.D.	Oct. 20, 1893,	Historical Soc., Boston, Mass.
1504.	GREEN, WILLIAM HENRY, D.D . .	April 17, 1863,	Princeton, N. J.
1880.	GREENE, WILLIAM H., M.D. . . .	April 18, 1879,	204 N. 36th St., Philadelphia.
2155.	DE GREGORIO, MARCHESE ANTONIO	Dec. 21, 1888,	Al Molo, Palermo, Sicily.
2188.	GREGORY, DR. CASPAR RÉNÉ. . .	May 15, 1891,	Naunhofstrasse 25, Marienhöhe, Leipzig-Stotteritz, Germany.
1815.	GROTE, AUGUSTUS RADCLIFFE . .	Oct. 20, 1876,	Buffalo, N. Y.
2090.	DE GUBERNATIS, ANGELO, Professor	May 21, 1886,	Florence, Italy.
1438.	DE GUYANGOS, DON PASCUAL . .	April 19, 1861,	London, England.

H

2054.	HAECKEL, ERNST, Professor Dr. . .	Oct. 16, 1885,	Univ. Jena, Germany.
1658.	HALE, REV. EDW. EVERETT . . .	Jan'y 21, 1870,	39 Highland St., Roxb'y, Mass.
1853.	HALL, ASAPH, Professor	Jan'y 18, 1878,	U. S. Observ., Washington, D.C.
1795.	HALL, CHARLES EDWARD.	Oct. 15, 1875,	Westport, Essex County, N. Y.
2219.	HALL, ISAAC H., Professor	May 19, 1893,	Metropolitan Museum of Art, Central Park, New York, N.Y.
1356.	HALL, JAMES, Prof.	July 21, 1854,	State Museum, Albany, N. Y.
2027.	HALL, LYMAN B., Prof.	Jan'y 16, 1885,	161 N. 15th St., Philadelphia.
1412.	HAMMOND, WILLIAM A., M.D. . .	Oct. 21, 1859,	Washington, D. C.

	Name.	*Date of Election.*	*Present Address.*
2194.	HAMY, DR. E. T.	May 15, 1891,	40 Rue Lübeck, Ave. du Trocadero, Paris, France.
1337.	HARDING, GEORGE	Jan'y 20, 1854,	2036 Chestnut St., Phila.
2136.	HARRIS, JOSEPH S.	May 20, 1887,	144 School Lane, Germantown, Philadelphia.
2246.	HARRISON, CHALES C., Provost.	Feb'y 15, 1895,	1618 Locust St., Philadelphia.
1827.	HART, JAMES MORGAN, Professor.	Feb'y 2, 1877,	Cornell Univ., Ithaca, N. Y.
2365.	HATCHER, JOHN B., Professor . .	Dec. 17. 1897,	Princeton, N. J.
1764.	VON HAUER, FRANZ RITTER. .	Oct. 16, 1874,	Leoben, Austria.
1681.	HÄUPT, HERMANN, General . . .	April 21, 1871,	747 Portland Ave., St. Paul, Minnesota.
1862.	HAUPT, LEWIS M., Professor . .	May 3, 1878,	107 N. 35th St., Philadelphia.
2082.	HAYES, RICHARD SOMERS	May 21, 1886,	32 Nassau St., New York, N.Y.
2071.	HAYS, I. MINIS, M.D.	Feb'y 19, 1886,	266 S. 21st St., Philadelphia.
1985.	HEILPRIN, ANGELO, Professor . .	April 20, 1883,	Acad. of Nat. Sciences, Phila.
2283.	HENDERSON, C. H	May 15, 1896,	Philadelphia.
2218.	HEWETT, WATERMAN T., Prof. . .	May 19, 1893,	Cornell Univ., Ithaca, N. Y.
2266.	HEYSE, PAUL, DR.	May 17, 1895,	Munich, Bavaria.
2349.	HILDEBURN, CHARLES R	Oct. 15, 1897,	1015 Clinton Street, Phila.
2307.	HILLER, H. M., M.D.	Feb'y 19, 1897,	350 S. 16th Street, Phila.
2110.	HILPRECHT, HERMANN V., Prof.	Dec. 17, 1886,	1031 Walnut St., Philadelphia.
1768.	HIMES, CHARLES FRANCIS . . .	Oct. 16, 1874,	Dickinson Coll., Carlisle Pa.
1663.	HITCHCOCK, CHAS. HENRY, Prof.	April 15, 1870,	Dartmouth College, Hanover, N. H.
2160.	HOFFMAN, WALTER J., M.D . . .	Oct. 18, 1889,	U. S. Consulate, Manheim, Germany.
2355	HOLDEN, EDWARD S.	Dec. 17, 1897,	Smithsonian Institution, Washington, D. C.
2068.	HOLLAND, JAMES W., M.D. . . .	Feb'y 19, 1886,	2006 Chestnut St., Philadelphia.
1624.	HOOKER, SIR JOSEPH D.	Jan'y 15, 1869,	The Camp, Sunningdale, Eng.
2224.	HOPPIN, J. M., Professor	Oct. 20, 1893,	New Haven, Conn.
2070.	HORNER, INMAN.	Feb'y 19, 1886,	1811 Walnut St., Philadelphia.
1941.	HOTCHKISS, JEDEDIAH.	Oct. 21, 1881,	346 E. Beverly St , Staunton, Va.
1696.	HOUGH, GEORGE W., Professor . .	Jan'y 19, 1872,	N. W. Univ., Evanston, Ill.
1698.	HOUSTON, EDWIN J., Professor. .	Jan'y 19, 1872,	1809 Spring Garden St., Phila.
2346.	HOWE, HENRY M., Prof.	Oct. 15, 1897,	27 W. 73d St., New York.
2239.	HUGGINS, WILLIAM.	Feb'y 15, 1895,	90 Upper Tulse Hill, S. W. London, England.
1843.	HUMPHREY, H. C.	July 20, 1877,	44 Broadway, New York, N.Y.
2248.	HUNTER, RICHARD S.	Feb'y 15, 1895,	1413 Locust St., Philadelphia.
2231.	HYATT, ALPHEUS, Professor. . .	Feb'y 15, 1895,	Cambridge, Mass.
1426.	HYRTL, JOSEPH, Professor. . . .	July 20, 1860,	k. k. Akad. d. Wissenschaften, Vienna, Austria.

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1773.	INGHAM, WM. ARMSTRONG. . . .	April 16, 1875,	320 Walnut St., Philadelphia.
2221.	D'INVILLIERS, EDWARD VINCENT.	May 19, 1893,	711 Walnut St., Philadelphia.

J

2010.	JAMES, EDMUND J., Prof.	April 18, 1884,	Univ. of Chicago, Chicago, Ill.
1933.	JANNET, CLAUDIO	April 15, 1881,	11 Rue las Casas, Paris, France.
2302.	JASTROW, MORRIS, JR.	Feb. 19, 1897,	248 S. 23d St., Philadelphia.
2049.	JAYNE, HORACE, M.D.	Oct. 16, 1885,	318 S. 19th St., Philadelphia.

	Name.	*Date of Election.*	*Present Address.*
1954.	JEFFERIS, WILLIAM W	Jan'y 20, 1882,	1836 Green St., Philadelphia.
2017.	JORDAN, FRANCIS, JR.	April 18, 1884,	111 N. Front St., Philadelphia.

K

1989.	KANE, ELISHA KENT.	April 20, 1883,	Kane, Pa.
2322.	KARPINSKI, ALEX. PETROVITCH .	May 21, 1897,	Geological Survey, St. Petersburg, Russia.
2169.	KEANE, JOHN J., Right Rev. . .	Dec. 20, 1889,	Washington, D. C.
2329.	KEEN, GREGORY B.	Oct. 15, 1897,	3237 Chestnut St., Philadelphia.
2021.	KEEN, WILLIAM W., M.D., Prof.	July 18, 1884,	1729 Chestnut St., Philadelphia.
1723.	KELVIN, LORD, (Sir Wm. Thomson).	April 18, 1873,	University of Glasgow, Glasgow, Scotland.
1161.	KENDALL, E. OTIS, Professor . .	Jan'y 21, 1842,	"The Stratford," Philadelphia.
2278.	KENNELLY, A. E., D.Sc	Feb. 28, 1896,	1105 Betz Building, Phila.
2118.	KIEPERT, HENRY, Professor Dr.	Dec. 17, 1886,	Berlin, Germany.
1708.	KING, CLARENCE.	Oct. 18, 1872,	18 Wall St., New York, N. Y.
1767.	KÖNIG, GEORGE A., Professor . .	Oct. 16, 1874,	Sch. of Mines, Houghton, Mich.
2167.	KRAUSS, FRIEDERICH S., Dr. . .	Dec. 20, 1889,	VII Neustiftgasse 12, Vienna.

L

1694.	LAMBERT, GUILLAUME, Professor.	Jan'y 19, 1872,	Univ. of Louvain, Belgium.
2344.	LANCIANI, RUDOLFO	Oct. 15, 1897,	2 Via Goito, Rome, Italy.
1858.	LANDRETH, BURNET.	Jan'y 18, 1878,	Bristol, Pa.
1781.	LANGLEY, SAMUEL P., Professor .	April 16, 1875,	Smithsonian Institution, Washington, D. C.
1721.	LA ROCHE, C. PERCY, M.D. . . .	Jan'y 17, 1873,	1518 Pine Street, Philadelphia.
1974.	LAWES, SIR JOHN B.	Jan'y 19, 1883,	Rothamstead, Herts, England.
1595.	LEA, HENRY CHARLES.	Oct. 18, 1867,	2000 Walnut St., Philadelphia.
1737.	LE CONTE, JOSEPH, Professor . .	April 18, 1873,	Univ. of California, Berkeley, Cal.
2241.	LEGGE, JAMES, Rev	Feb. 15, 1895,	Oxford, England.
1986.	LEHMAN, AMBROSE E.	April 20, 1883,	711 Walnut St., Philadelphia.
2182.	LELAND, CHARLES G.	May 16, 1890,	Baring Bros. & Co., London, England.
2174.	LE MOINE, HON. J. M.	Dec. 20, 1889,	Quebec, Canada.
2324.	LEONARD, JAMES B.	Oct. 15, 1897,	1813 Spruce St., Philadelphia.
1382.	LESLEY, J. PETER, Professor. . .	July 13, 1856,	Milton, Mass.
2085.	LEVASSEUR, EMILE, Professor . .	May 21, 1886,	26, Rue Mons le Prince, Paris.
1415.	LEWIS, FRANCIS W., M.D.	Jan'y 20, 1860,	2016 Spruce St., Philadelphia.
2300.	LEWIS, G. ALBERT	Dec. 18, 1896,	1834 Delancey Place, Philadelphia.
2338.	LIBBEY, WILLIAM, Professor. . .	Oct. 15, 1897,	Princeton, N. J.
2312.	LISTER, THE RIGHT HON. LORD .	May 21, 1897,	12 Park Crescent, Portland Place, London, Eng.
1756.	LOCKYER, SIR JOSEPH NORMAN, K. C. B	April 17, 1874,	Royal Col. of Sci., S. Kensington, London S. W., England.
1728.	LONGCHAMPS, BARON DE SELYS .	April 18, 1873,	Liège, Belgium.
1872.	LONGSTRETH, MORRIS, M.D. . . .	Sept. 20, 1878,	1416 Spruce St., Philadelphia.
2202.	LOW, HON. SETH	Feb. 19, 1892,	Columbia College, New York.
2350.	LOWELL, PERCIVAL.	Oct. 15, 1897,	Lowell Obs., Flagstaff, Arizona.
2019.	LUBBOCK, SIR JOHN	July 18, 1884,	15 Lombard St., London, Eng.
2003.	LUDLOW, WILLIAM, Col. U. S. A.	Jan'y 18, 1884,	Army Building, 39 Whitehall St., New York.
1629.	LYMAN, BENJAMIN SMITH	Jan'y 15, 1869,	708 Locust St., Philadelphia.

M

	Name.	*Date of Election.*	*Present Address.*
2319.	MABERY, CHARLES F., Prof. . . .	May 21, 1897,	Case School of Applied Science, Cleveland, O.
2107.	MACALISTER, JAMES, Pres.	Dec. 17, 1886,	119 N. 18th St., Philadelphia.
2209.	MACFARLANE, JOHN M., Prof. . .	Dec. 16, 1892,	Lansdowne, Delaware Co., Pa.
2334.	MACVEAGH, WAYNE, HON	Oct. 15, 1897,	Bryn Mawr, Pennsylvania.
2363.	MCCAY, LEROY W., Prof.	Dec. 17, 1897,	Princeton, N. J.
2366.	MCCLURE, CHARLES F. W., Prof.	Dec. 17, 1897,	Princeton, N. J.
2280.	MCCOOK, HENRY C., Rev., D.D. .	Feb. 28, 1896,	3700 Chestnut St., Philadelphia.
1888.	MCCREATH, ANDREW S.	July 18, 1879,	223 Market St., Harrisburg, Pa.
1821.	MCKEAN, WILLIAM V.	Feb'y 2, 1877,	200 N. 19th St., Philadelphia.
2299.	MAGIE, WM. FRANCIS, Prof. . . .	Dec. 19, 1896,	Princeton, N. J.
2339.	MAHAN, ALFRED T., Capt. U. S. N.	Oct. 15, 1897,	160 W. 86th St., New York.
2042.	MALLET, JOHN WM., M.D. . . .	Jan'y 16, 1885,	University of Virginia, Charlottesville, Va.
1847.	MANSFIELD, IRA FRANKLIN . . .	Jan'y 18, 1878,	Cannelton, Beaver Co., Pa.
1857.	MARCH, FRANCIS ANDREW, Prof.	Jan'y 18, 1878,	Lafayette College, Easton, Pa.
1861.	MARKS, WILLIAM D., Professor .	May 3, 1878,	1014 Betz Bldg., Philadelphia.
1604.	MARSH, OTHNIEL C., Professor. . .	Oct. 16, 1868,	Yale University, New Haven, Conn.
2078.	MARSHALL, JOHN, M.D	May 21, 1886,	1409 Spruce St,, Philadelphia.
2184.	MASCART, E., Professor	Dec. 19, 1890,	176 Rue de l'Université, Paris.
1572.	MASON, ANDREW, ...	Jan'y 18, 1867,	30 and 32 Wall St., New York.
2196.	MASPERO, GASTON, Professor . . .	May 15, 1891,	Paris, France.
2279.	MASON, WM. PITTS, M.D., Prof. .	Feb. 28, 1896,	Rensselaer Polytechnic Institute, Troy, N. Y.
1677.	MEEHAN, THOMAS	Jan'y 29, 1871,	Germantown, Philadelphia.
2115.	VON MELTZEL, HUGO, Prof. Dr. .	Dec. 17, 1886,	Koloszvar, Hungary.
2339.	MELVILLE, GEORGE WALLACE, Com. U. S. N..	Oct. 15, 1897,	Navy Dept., Washington, D. C.
2251.	MERCER, HENRY C.	Feb. 15, 1895,	Doylestown, Pa
1903.	MERRICK, JOHN VAUGHAN. . . .	April 16, 1880,	Roxborough, Philadelphia.
1947.	MERRIMAN, MANSFIELD, Prof. .	Oct. 21, 1881,	Lehigh Univ., Bethlehem, Pa.
1744.	MESSCHERT, MATTHEW HUIZINGA.	Oct. 17, 1873,	Douglassville, Berks Co., Pa.
2142.	MICHAEL, MRS. HELEN ABBOTT.	May 20, 1887,	44 Mt. Vernon St., Boston, Mass.
2284.	MINOT, CHAS. SEDGWICK, M.D. .	May 15, 1896,	Harvard Univ., Cambridge.
2175.	MITCHELL, HON. JAMES T. . . .	Feb'y 21, 1890,	1722 Walnut St., Philadelphia.
1461.	MITCHELL, S. WEIR, M.D	Jan'y 17, 1862,	1524 Walnut St., Philadelphia.
2267.	MONTEGAZZA, PAOLO	May 17, 1895,	Florence, Italy.
2323.	MOORE, CLARENCE B.	Oct. 15, 1897,	1321 Locust Street, Phila.
2029.	MOORE, JAMES W., M.D.	Jan'y 16, 1885,	Lafayette College, Easton, Pa.
1841.	MOREHOUSE, GEORGE R., M.D. .	April 20, 1877,	2033 Walnut St., Philadelphia.
2340.	MORLEY, FRANK, Professor . . .	Oct. 15, 1897,	Haverford, Pa.
1976.	MORRIS, J. CHESTON, M.D. . . .	Jan'y 19, 1883,	1514 Spruce St., Philadelphia.
2265.	MORSE, EDWARD S., Professor . .	May 17, 1895,	Essex Institute, Salem, Mass.
2242.	DE MORTILLET, GABRIEL . . .	Feb. 15, 1895,	St. Germain-en-Laye, France.
1577.	MORTON, HENRY, President . . .	Jan'y 18, 1867,	Hoboken, N. J.
2121.	MUCH, DR. MATTHÆUS.	Dec. 17, 1886,	XIII Penzingerstrasse 84, Vienna.
2120.	MUELLER, DR. FRIEDERICH . . .	Dec. 17, 1886,	XIII Marxergasse 24, Vienna.
1486.	MUELLER, F. MAX, Professor . .	Jan'y 16, 1863,	Univ. Oxford, England.
1866.	MUHLENBERG, REV. FRED A. . .	Sept. 20, 1878,	34 S. 5th St., Reading, Pa.
2192.	MUNROE, CHARLES E., Professor.	May 15, 1891,	Columbian Univ. Washington, D. C.
2062.	MURDOCK, J. B., Lieut. U.S.N . .	Feb'y 19, 1886,	Navy Dept., Washington, D.C.

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	Name.	*Date of Election*	*Present Address.*
1937.	MURRAY, JAMES A. H., Dr . . .	April 15, 1881,	Oxford, England.
2087.	DE NADAILLAC, MARQUIS.	May 21, 1886,	18 Rue Duphot, Paris, France.
2316.	NANSEN, FRIDTJOF	May 21, 1897,	Lysaker, Norway.
1852.	NEWCOMB, SIMON, Professor . . .	Jan'y 18, 1878,	U. S. Nautical Almanac Office, Washington, D. C.
1703.	NICHOLS, STARR HOYT	July 19, 1872,	64 Exchange Pl., New York, N.Y.
2060.	NIKITIN, SERGE, Chief Geolog .	Feb'y 19, 1866,	Geological Survey, St. Petersburg, Russia.
1805.	NORDENSKIÖLD, ADOLF ERIC, Prof.	April 21, 1876,	Stockholm, Sweden.
1712.	NORRIS, ISAAC, M.D.	Oct. 18, 1872,	2043 Walnut St., Philadelphia.
2106.	NORRIS, WILLIAM F., M.D. . . .	Dec. 17, 1886,	1530 Locust St., Philadelphia.
2046.	NORTH, EDWARD, LL.D., Prof . .	Oct. 16, 1885,	Hamilton College, Clinton, N.Y.
2269.	NUTTALL, MRS. ZELIA	May 17, 1895,	Beuststrasse 17, Dresden.

O

2072.	OLIVER, CHARLES A., M.D. . . .	Feb'y 19, 1886,	1507 Locust St., Philadelphia.
2354.	OLNEY, RICHARD, Hon	Dec. 17, 1897,	23 Court Street, Boston.
2195.	OPPERT, JULIUS, Professor Dr . .	May 15, 1891,	Paris, France.
2362.	ORTMANN, ARNOLD E., Prof . . .	Dec. 17, 1897,	Princeton, N. J.
2320.	ORTON, EDWARD	May 21, 1897,	State University, Columbus, O.
2135.	OSBORN, HENRY F., Professor. .	Feb'y 18, 1887,	Amer. Museum of Natural History, New York City.
2039.	OSLER, WILLIAM, M.D	Jan'y 16, 1885,	1 West Franklin St., Baltimore, Md.

P

1868.	PACKARD, A. S., Dr	Sept. 20, 1878,	Providence, R. I.
1578.	PACKARD, JOHN H., M.D.	Jan'y 18, 1867,	Hotel Stenton, Philadelphia.
1331.	PAGET, SIR JAMES, Bart	Jan'y 20, 1854,	5 Park Square W., Regents Park, London, England.
2035.	PATTERSON, C. STUART.	Jan'y 16, 1885,	1000 Walnut St., Philadelphia.
1282.	PATTERSON, ROBERT	April 18, 1851,	329 Chestnut St., Philadelphia.
1320.	PATTERSON, THOMAS LEIPER . .	April 15, 1853,	176 Washington St., Cumberland, Md.
2213.	PATTISON, ROBERT E., Hon . . .	Feb. 17, 1893,	5930 Drexel Rd., Overbrook, Pa.
2357.	PATTON, FRANCIS L., D.D., Pres't	Dec. 17, 1897,	Princeton, N. J.
1772.	PEARSE, JOHN B.	Jan'y 15, 1875,	317 Walnut Av., Roxbury, Mass.
2318.	PECKHAM, S. F.	May 21, 1897,	Univ. Mich., Ann Arbor, Mich.
1859.	PEIRCE, C. NEWLIN, D.D.S. . . .	May 3, 1878,	1415 Walnut St., Philadelphia.
1722.	PEMBERTON, HENRY.	Jan'y 17, 1873,	1947 Locust St., Philadelphia.
2104.	PEÑAFIEL, ANTONIO, Dr.	May 21, 1886,	Ciudad, Mexico, Mexico.
2073.	PENNYPACKER, SAMUEL W., Hon.	May 21, 1886,	1540 N. 15th St., Philadelphia.
1518.	PENROSE, R. A. F., M.D.	July 17, 1863,	1331 Spruce St., Philadelphia.
2059.	PEPPER, EDWARD, M.D.	Feb'y 19, 1886,	El Afia, El Biar, Alger, Algerie.
2333.	PEPPER, GEORGE WHARTON . . .	Oct. 15, 1897,	701 Drexel Building, Phila.
1666.	PEPPER, WILLIAM, M.D.	July 15, 1870,	1811 Spruce St., Philadelphia.
2281.	PETTIT, HENRY	Feb. 28, 1895,	5951 Overbrook Ave., Phila.
2261.	PHELPS, EDWARD J., Hon. . . .	May 17, 1895,	Burlington, Vt.
2295.	PICKERING, EDW. C., Professor .	May 15, 1896,	Harvard Univ. Observatory, Cambridge, Mass.
2342.	PIERSOL, GEORGE A , M.D.	Oct. 15, 1897,	Chester Ave. and 49th St., Phila.
2277.	PILSBRY, HENRY A., Professor. .	Dec. 20, 1895,	Acad. Nat. Sci., Philadelphia.

	Name.	*Date of Election.*	*Present Address.*
1760.	PLATT, FRANKLIN	July 17, 1874,	1617 Chestnut St., Philadelphia.
2127.	PLATZMANN, JULIUS, Dr.	Dec. 17, 1886,	Reichsstrasse 2, Leipzig.
2053.	POMIALOWSKY, JOHN, Professor .	Oct. 16, 1885,	St. Petersburg, Russia.
1539.	PORTER, THOMAS C., Rev.	Oct. 21, 1864,	Lafayette College, Easton, Pa.
2097.	POSTGATE, J. P., Professor	May 21, 1886,	Cambridge, England.
2161.	POWELL, J. W., MAJOR.	Oct. 18, 1889,	910 M. St., N. W., Washington, D. C.
1780.	PRIME, FREDERICK.	April 16, 1875,	1008 Spruce St., Philadelphia.
2088.	PULZSKY, FRANCIS, Dr	May 21, 1886,	Buda-Pesth, Hungary.
1758.	PUMPELLY, RAPHAEL	April 17, 1874,	Newport, R. I.
2293.	PUPIN, MICHAEL I., Professor . .	May 15, 1896,	7 Highland Pl., Yonkers, N. Y.
2268.	PUTNAM, F. W., Prof.	May 15, 1895,	Harvard Univ., Cambridge, Mass.

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2131.	RADA, JUAN DE DIOS-Y DELGADO,	Dec. 17, 1886,	Calle de la Corredera baja de S. Pablo No. 12, Madrid, Spain.
1736.	RAND, THEODORE D'.	April 18, 1873,	Radnor, Del.Co., Pennsylvania.
1849.	RANDALL, F. A., Dr	Jan'y 18, 1878,	Warren, Pa.
1644.	RAWLINSON, GEORGE, Professor .	Oct. 15, 1869,	Oxford, England.
1765.	RAWSON, SIR RAWSON W.	Oct. 16, 1874,	68 Cornwall Gardens, Queen's-gate, London S.W., England.
2099.	RAYLEIGH, LORD.	May 21, 1886,	Terling Pl., Witham, Essex, Eng.
1784.	RAYMOND, ROSSITER W.	April 16, 1875,	13 Burling Slip, New York, N.Y.
1889.	REMSEN, IRA, Professor.	July 18, 1879,	Johns Hopkins Univ. Baltimore, Md.
1948.	RENARD, A. F., Professor	Oct. 21, 1881,	Acad. of Sci., Brussels, Belgium.
1343.	RENARD, CHARLES, M.D.	Jan'y 20, 1854,	Moscow, Russia.
1890.	RENEVIER, E., Professor.	July 18, 1879,	Univ. Lausanne, Switzerland.
1816.	REULEAUX, F., Professor Dr . . .	Feb'y 2, 1877,	Ahornstrasse 2, Berlin.
2122.	RÉVILLE, ALBERT, Professor Dr .	Dec. 17, 1886,	21 Rue Guénégaud, Paris.
2315.	RHOADS, SAMUEL NEELY	May 21, 1897,	Acad. Nat. Sci., Philadelphia.
2226.	ROBERTS, ISAAC, Dr.	Oct. 20, 1893,	Starfield, Crowborough, Sussex, England.
1957.	ROBINS, JAMES W., Rev	April 21, 1882,	Merion Station, Montg. Co., Pa.
1390.	ROGERS, FAIRMAN	Jan'y 16, 1857,	Univ. of Pa., Philadelphia.
2177.	ROGERS, ROBERT W., Professor. .	Feb'y 21, 1890,	Drew Theological Seminary, Madison, N. J.
1462.	ROHRIG, F. L. OTTO, Professor . .	April 18, 1862,	Los Angeles, Cal.
2050.	ROLLETT, HERMANN, Dr.	Oct. 16, 1885,	Baden bei Wien, Austria.
1907.	ROOD, OGDEN N., Professor. . . .	April 16, 1880,	Columbia College, New York City.
2198.	ROSENGARTEN, JOSEPH G.	Oct. 16, 1891,	1704 Walnut St., Philadelphia.
1964.	DE ROSNY, LÉON, Professor. . . .	July 21, 1882,	47 Ave. Duquêsne, Paris.
1838.	ROTHROCK, JOSEPH T., Professor	April 20, 1877,	West Chester, Pa.
2291.	ROWLAND, HENRY A., Professor .	May 15, 1896,	Johns Hopkins Univ., Baltimore, Md.
1620.	RÜTIMEYER, DR. CARL L., Prof. .	Jan'y 15, 1869,	Basle, Switzerland.

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2230.	SACHSE, JULIUS F.	Feb'y 16, 1894,	4428 Pine St., Philadelphia.
1766.	SADTLER, SAMUEL P., Prof. . . .	Oct. 16, 1874,	1042 Drexel Building, Phila.
2148.	SAJOUS, CHARLES E., M.D	Feb'y 17, 1888,	2043 Walnut St., Philadelphia.
2358.	SAMPSON, ALDEN.	Dec. 17, 1897,	Haverford, Pa.

	Name.	*Date of Election.*	*Present Address.*
1563.	SANDBERGER, FREDOLIN, Prof. .	April 20, 1866,	Univ. of Würtzburg, Bavaria.
2327.	SANDERS, RICHARD H.	Oct. 15, 1897,	1225 Locust St., Philadelphia.
1958.	SARGENT, CHARLES SPRAGUE, Prof.	April 21, 1882,	Jamaica Plain, Mass.
1730.	SAUSSURE, HENRI DE.	April 18, 1873,	Geneva, Switzerland.
2211.	SCHÄFFER, CHARLES, M.D. . . .	Feb'y 17, 1893,	1309 Arch St., Philadelphia.
1498.	SCHOTT, CHARLES ANTHONY, Prof.	April 17, 1863,	U. S. Coast and Geodetic Survey, Washington, D. C.
1864.	SCHURZ, CARL, Hon	Sept. 20, 1878,	54 William St., New York, N.Y.
1725.	SCLATER, PHILLIP LUTLEY.	April 18, 1873,	3 Hanover Square, London, England.
2112.	SCOTT, W. B., Prof.	Dec. 17, 1886,	Princeton, N. J.
1870.	SCUDDER, SAMUEL HUBBARD. . .	Sept. 20, 1878,	Cambridge, Mass.
2352.	SEE, T. J. J., Ph.D	Dec. 17, 1897,	Lowell Observatory, Flagstaff, Ariz.
1704.	SELLERS, COLEMAN	July 19, 1872,	3301 Baring St., Philadelphia.
1533.	SELLERS, WILLIAM.	April 15, 1864,	Clifton, Edgemoor, Delaware.
1770.	SELWYN, ALFRED R. C., Dr. . . .	Oct. 16, 1874,	28 Nepean St., Ottawa, Canada.
2057.	SERGI, GIUSEPPE, Prof.	Oct. 16, 1885,	Università Romana, Rome, Italy
2076.	SHARP, BENJAMIN, M.D.	May 21, 1886,	317 N. 35th St., Philadelphia.
1944.	SHARPLES, PHILIP PRICE	Oct. 21, 1881,	West Chester, Pennsylvania.
1960.	SHARPLES, STEPHEN PASCHALL. .	April 21, 1882,	13 Broad St., Boston, Mass.
1797.	SHERWOOD, ANDREW	Oct. 15, 1875,	Mansfield, Tioga Co., Penna.
1822.	SHIELDS, CHAS. W., D.D.	Feb'y 2, 1877,	Princeton, N. J.
2351.	SMITH, A. DONALDSON, M.D . . .	Oct. 15, 1897,	1811 Walnut St., Philadelphia.
2146.	SMITH, EDGAR F., Professor . . .	Oct. 21, 1887,	210 S. 37th St., Philadelphia.
1789.	SMITH, STEPHEN, M.D	Oct. 15, 1875,	57 W. 42d St., New York, N. Y.
2335.	SMOCK, JOHN C.	Oct. 15, 1897,	Trenton, N. J.
2141.	SMYTH, ALBERT H., Professor,	May 20, 1887,	Radnor, Delaware Co., Pa.
2229.	SNELLEN, HERMAN, JR., Dr. . .	Feb'y 16, 1894,	Utrecht, Netherlands.
1724.	SNOWDEN, A. LOUDON	Oct. 17, 1873,	1812 Spruce St., Philadelphia.
2009.	SNYDER, MONROE B., Professor .	Jan'y 18, 1884,	2402 N. Broad St., Philadelphia.
1720.	SPOFFORD, A. R., ...	Jan'y 17, 1873,	Washington, D. C.
2332.	SQUIBB, EDWARD R., M.D	Oct. 15, 1897,	Brooklyn, N. Y.
1949.	STALLO, HON. JOHN B.	Oct. 21, 1881,	Cincinnati, O.
2348.	STEPHENS, H. MORSE, Prof. . . .	Oct. 15, 1897,	Cornell Univ., Ithaca, N. Y.
1990.	STEVENS, WALTER LECONTE, Prof.	Jan'y 18, 1884,	Rensselaer Polytechnic Institute, Troy, N. Y.
1840.	STEVENSON, JOHN JAMES, Prof. .	April 20, 1877,	Univ. Heights, New York, N.Y.
2276.	STEVENSON, SARA Y.	Oct. 18, 1895,	237 S. 21st St., Philadelphia.
2168.	STOKES, SIR GEORGE G.	Dec. 20, 1889,	Linfield Cottage, Cambridge, England.
2193.	STUBBS, WILLIAM, Rt. Rev., D.D.	May 15, 1891,	Cleveden Palace, Oxford, Eng.
2094.	SUESS, EDWARD, Professor	May 21, 1886,	Geol. Reichsanstalt, Vienna.
2258.	SULZBERGER, MAYER, Hon. . . .	May 17, 1895,	1303 Girard Ave., Philadelphia.
2092.	SZOMBATHY, JOSEF, Professor . .	May 21, 1886,	Burgring 7, Vienna, Austria.

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2328.	TATHAM, WILLIAM	Oct. 15, 1897,	1811 Walnut St., Philadelphia.
1786.	TATHAM, WILLIAM P.	April 16, 1875,	1420 Walnut St., Philadelphia.
2243.	TAYLOR, ISAAC, D.D., Rev. . . .	Feb'y 15, 1895,	York, England.
2098.	TEMPLE, RICHARD CARNAC, Lieut-Col.	May 21, 1886,	Government House, Port Blair, Andeman Islands, E. Indies.
2289.	TESLA, NIKOLA	May 15, 1896,	46 E. Houston St., New York City.

	Name.	*Date of Election.*	*Present Address.*
2006.	THOMAS, ALLEN C., Professor. .	Jan'y 18, 1884,	Haverford, Pa.
1993.	THOMPSON, HEBER S.	Jan'y 18, 1884,	Pottsville, Pa.
1726.	THOMPSON, SIR HENRY.	April 18, 1873,	35 Wimpole St., Cavendish Square, London, England.
1807.	THOMSON, ELIHU, Professor . . .	April 21, 1876,	Swampscott, Mass.
1754.	THOMSON, FRANK	April 17, 1874,	Merion, Penna.
1909.	THOMSON, WILLIAM, M.D.	April 16, 1880,	1426 Walnut St., Philadelphia.
2052.	IM THURN, EVERARD F.	Oct. 16, 1885,	Pomeroon River, Georgetown, British Guiana, S. A.
1530.	THURY, A., Professor	April 15, 1864,	Univ. Geneva, Switzerland.
1688.	TILGHMAN, BENJAMIN C., Gen . .	July 21, 1871,	1114 Girard St., Philadelphia.
1233.	TILGHMAN, RICHARD A.	April 16, 1847,	321 S. 11th St., Philadelphia.
1657.	TILGHMAN, WILLIAM M.	Jan'y 21, 1870,	1114 Girard St., Philadelphia.
2176.	TIMMINS, SAMUEL	Feb. 21, 1890,	Arley, near Coventry, England.
2123.	TOPINARD, DR. PAUL.	Dec. 17, 1886,	105 Rue de Rennes, Paris.
2065.	TOPPAN, ROBERT NOXON.	Feb'y 19, 1886,	10 Highland St., Cambridge, Mass.
2249.	TOWER, CHARLEMAGNE, JR., Hon.	Feb'y 15, 1895,	U S. Embassy, Vienna, Austria.
2309.	TRIMBLE, HENRY.	Feb. 19, 1897,	St. David's, Pennsylvania
2288.	TROWBRIDGE, JOHN, Professor . .	May 15, 1896,	Harv. Univ., Cambridge, Mass.
2024.	TRUMBULL, HENRY C., D.D., Rev.	July 18, 1884,	1031 Walnut St., Philadelphia.
2321.	TSCHERNYSCHEW, THEODORE. . .	May 21, 1897,	Geological Survey, St. Petersburg, Russia.
1973.	TSCHERMAK, GUSTAV, ...	Oct. 20, 1882,	Universität. Vienna, Austria.
1529.	V. TUNNER, PETER R., Professor..	April 15, 1864,	Leoben, Austria.
1983.	TURRETTINI, THEODORE, Prof .	Dec. 19, 1890,	Geneva, Switzerland.
2166.	TUTTLE, DAVID K	Oct. 18, 1889,	U. S. Mint, Philadelphia.
2163.	TYLER, LYON G., Hon., President	Oct. 18, 1889,	Williamsburg, Va.
2138.	TYSON, JAMES, M.D	May 20, 1887,	1506 Spruce St., Philadelphia.

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2185.	UNWIN, WILLIAM C., Professor. .	Dec. 19, 1890,	7 Palace Gate Mansions, London, England.

V

2325.	VAUX, GEORGE, JR.	Oct. 15, 1897,	404 Girard Building, Phila.
2045.	DE VERE, M. SCHELE, Professor .	Oct. 16, 1885,	University of Virginia, Charlottesville, Albemarle Co., Va.
1475.	VIRCHOW, RUDOLPH, Prof. Dr . .	Oct. 17, 1862,	Universität, Berlin, Germany.
1670.	VOSE, GEORGE L., Professor . . .	Oct. 21, 1870,	Massachusetts Institute of Technology, Boston.
2186.	VOSSION, LOUIS	Dec. 19, 1890,	Consulate of France, Honolulu.

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2034.	WAGNER, SAMUEL	Jan'y 16, 1885,	133 S. 12th St., Philadelphia.
1748.	WAHL, WILLIAM H.	Jan'y 16, 1874,	15 S. 7th St., Philadelphia.
2331.	WALCOTT, CHARLES D., Director .	Oct. 15, 1897,	U. S. Geological Survey, Washington, D. C.
1724.	WALLACE, ALFRED R.	April 18, 1873,	Parkstone, Dorset, England.

	Name.	*Date of Election.*	*Present Address.*
2156.	WARD, LESTER F.	May 17, 1889,	1464 Rhode Island Ave., Washington, D. C.
2359.	WARFIELD, ETHELBERT D., Pres't	Dec. 17, 1897,	Easton, Pennsylvania.
2033.	WEIL, EDWARD HENRY	Jan'y 16, 1885,	1720 Pine St., Philadelphia.
2028.	WEISBACH, PROF. DR. ALBIN. . .	Jan'y 16, 1885,	Bergakad, Freiberg, Saxony.
2286.	WELCH, WILLIAM H., M.D. . . .	May 15, 1896,	Johns Hopkins Univ., Baltimore, Md.
1639.	WHARTON, JOSEPH.	April 16, 1869,	P. O. Box 1332, Philadelphia.
1637.	WHITE, ANDREW D., Professor.	April 16, 1869,	Cornell Univ., Ithaca, N. Y.
1848.	WHITE, ISRAEL C., Professor . .	Jan'y 18, 1878,	West Virginia Univ., Morgantown, W. Va.
1863.	WILDER, BURT G., Professor . .	May 3, 1878,	Cornell Univ., Ithaca, N. Y.
2250.	WILLCOX, JOSEPH	Feb. 15, 1895,	The Gladstone, Philadelphia.
2347.	WILLIAMS, EDWARD H., JR., Prof.	Oct. 15, 1897,	Lehigh Univ., Bethlehem, Pa.
2114.	WILLIAMS, SIR MONIER-MONIER..	Dec. 17, 1886,	Onslow Gardens, London S.W., England.
2151.	WILLIAMS, TALCOTT	May 18, 1888,	916 Pine Street, Philadelphia.
2178.	WILLIS, HENRY, Professor	Feb'y 21, 1890,	4036 Baring St., Philadelphia.
2041.	WILSON, JAMES CORNELIUS, M.D.	Jan'y 16, 1885,	1437 Walnut St., Philadelphia.
1747.	WILSON, JOSEPH M.	Jan'y 16, 1874,	1036 Drexel Building, Phila.
2137.	WILSON, WILLIAM P., M.D. . .	May 20, 1887,	640 N. 32d St., Philadelphia.
2341.	WILSON, WOODROW, Professor . .	Oct. 15, 1897,	Princeton, N. J.
2220.	WISTAR, GEN. ISAAC J	May 19, 1893,	269 Broad Street Station, Phila.
2314.	WISTER, OWEN	May 21, 1897,	328 Chestnut Street, Phila.
2343.	WITMER, LIGHTNER, Professor. .	Oct. 15, 1897,	University of Penna., Phila.
1884.	WOOD, RICHARD.	April 18, 1879,	1620 Locust St , Philadelphia.
1762.	WOODWARD, HENRY.	July 17, 1874,	British Museum, London S.W., England.
1751.	WOOTTEN, J. E.	Jan'y 16, 1874,	226 N. 6th Ave., Reading, Pa.
2290.	WRIGHT, ARTHUR W., Professor .	May 15, 1896,	Yale Univ., New Haven, Conn.
2244.	WUNDT, WILLIAM, Professor. . .	Feb. 15, 1895,	Leipzig, Germany.
1932.	WURTS, DR. CHARLES STEWART .	Jan'y 21, 1881,	1701 Walnut St., Philadelphia.
2061.	WYCKOFF, LIEUT. A. B.	Feb'y 19, 1886,	North Yakima, Washington.

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1904.	YARNALL, ELLIS	April 16, 1880,	105 S. Front St , Philadelphia.
1759.	YOUNG, CHARLES AUGUSTUS, Prof.	April 17, 1874,	Princeton, N. J.